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Fossil Plants   Devonian and Upper Silurian formations

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GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, F.G.S., DIRECTOR.

THE FOSSIL PLANTS OF THE DEVONIAN AND UPPER SILURIAN FORMATIONS OF CANADA,

BY

J. W. DAWSON, LL.D., F.R.S., F.G.S.

WITH TWENTY PLATES.

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* A few generic terms, rejected or not used in the text, are introduced here to facilitate reference.

REPORT

ON THE

FOSSIL LAND PLANTS

OF THE

DEVONIAN AND UPPER SILURIAN FORMATIONS

OF

CANADA.

BY J. W. DAWSON, LL.D., F.R.S., F.G.S.

To ALFRED R. C. SELWYN, Esq., F.G.S.,
Director of the Geological Survey of Canada.

SIR,

The Report which by your request I have the honour to present herewith, includes the results of researches in the Devonian and Upper Silurian Flora of Canada, prosecuted for several years, and now brought to a conclusion, so far as the material at present accessible will permit.

For the purpose of these researches I have had in my hands the collections of the Geological Survey of Canada, and those made by Prof. Hartt for the Natural History Society of New Brunswick, and I have myself visited and largely collected in all the more important localities. I have also had the opportunity of studying the fossil plants collected by Prof. Hall in New York, and by Prof. Newberry in Ohio, and the more important collections in Great Britain.

I shall be able in the present Report to catalogue or describe more than one hundred and twenty species of Land Plants found in formations older than the Carboniferous in Canada and the neighbouring parts of North America; thus placing the knowledge of this old flora as it occurs in Canada, in advance of that of any other portion of the world.

I trust, therefore, that this Report, like Goeppert's and Unger's on the Devonian Flora of Europe, will, for some time at least, constitute a standard work of reference on this subject, not only in this country but abroad. It will also, no doubt, tend to stimulate further discoveries, and will afford to working geologists in this Dominion a satisfactory basis for the comparison of the Devonian and Carboniferous plants, a point very important in the investigation of our Coal-fields.

The descriptions in this Report are, with a few additions, and some changes rendered necessary by the more special reference to Canada, the same with those in my memoir on the Devonian Flora of North Eastern America, read before the Royal Society of London in 1870, and now in its archives.

I have the honour to be,
Your obedient Servant,
J. W. DAWSON.

M'GILL COLLEGE,
MONTREAL, *June* 26, 1871.

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I. HISTORICAL NOTICE OF THE PRE-CARBONIFEROUS FLORA OF CANADA, WITH ITS GEOLOGICAL RELATIONS.

My attention was first directed to the special study of the Devonian Flora by the discovery on the part of Sir W. E. Logan, in 1843, of numerous fossil plants in the sandstones of Gaspé Bay, named by him the "Gaspé Sandstones;" but it was not till 1859 that I had opportunities to examine Sir William's collections, and to visit Gaspé with the view of studying the plants in situ. In that year I communicated to the Geological Society of London my paper on the "Fossil Plants of the Devonian Rocks of Canada," in which I described the remarkable root-beds existing in the Gaspé Sandstones, and instituted the genera *Prototaxites* and *Psilophyton* for the reception of two of the more novel forms discovered. Since that time, I have extended my observations on the Devonian Flora to the rich plant-beds of St. John, New Brunswick, and Perry, Maine; and have enjoyed the opportunity of studying the fossil plants discovered in the Devonian of New York by the Geological Survey of that State, and kindly communicated to me by Prof. Hall. The results, embodying notices or descriptions of about eighty-two species, have been published in two papers in the Proceedings of the Geological Society of London,* and in so far as they relate to New Brunswick, in the second edition of my " Acadian Geology," 1868.

In the preparation of the latter work I had the advantage of examining a large collection from the prolific beds of Carlton, near St. John, New Brunswick, made a few years ago by Mr. (now Professor) Hartt, under the auspices of the Natural History Society of New Brunswick, and which may be regarded as almost exhaustive of that locality. A detailed section prepared by Prof. Hartt, and illustrating the distribution of the plants in the several beds, is also included in the notice of the locality in Acadian Geology.

Since the publication of the last-mentioned work, the explorations of the Geological Survey in the southern part of New Brunswick have traced the Devonian plant-beds to the westward of St. John, and have brought them into stratigraphical juxta-position with the Upper Silurian and Lower Carboniferous rocks of that region, thus farther confirming their geological age. Several new species, and specimens illustrative of forms previously known, have also been discovered, more especially at Lepreau and its vicinity. The researches of the officers of the Survey have also rendered it probable that the beds at Perry in Maine, which have afforded so many interesting fossils, may belong to a Devonian horizon somewhat higher than that of the St. John plant-beds, and that this may possibly serve to account for their comparatively unaltered condition. †

The large amount of material and of new facts to which I have thus had access, together with important discoveries made by Prof. Hall and Dr. Newberry in the Devonian of the United States, appeared to render possible a general revision of the whole Devonian Flora of Eastern America ; but, before attempting this, I was desirous to have the opportunity of revisiting and more fully exploring the cliffs of Gaspé Bay, with the view more particularly of studying the type of plant which had proved to be, of all others, most characteristic of the Devonian Flora, viz., the genus *Psilophyton*, and which occurs more abundantly, and in better preservation, there than at any other known locality. This design I carried out in the summer of 1869, under favorable circumstances as to weather, and with the valuable aid of Mr. G. T. Kennedy, B.A., and Mr. G. M. Dawson, both good collectors. The more fully to do justice to the work of exploration, we took with us a large boat and two boatmen, so that we could secure abundant and large specimens, and could take time to work out the connections of the plants in the beds in which they lie, points of ✓ the utmost importance in the study of fossil plants.

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* " On the Flora of the Devonian Period in North-Eastern America, "—1862. Further Observations on the Devonian Plants of Maine, Gaspé, and New York "—1863.

† The Perry beds rest uncomformably on a series of supposed Upper Silurian beds, which, traced eastwardly, probably underlie the Devonian plant-beds of Lepreau. The Flora of the Perry beds is precisely equivalent to that of the Upper Devonian of Pennsylvania and New York, and quite distinct from that of the Lower Carboniferous.

The Gaspé sandstones have been fully described by Sir W. E. Logan, in his Report on the Geology of Canada, 1863. He there assigns to them a thickness of 7036 feet, and shows that they rest conformably on the Upper Silurian limestones of the Lower Helderberg Group (Ludlow), and are in their turn overlaid unconformably by the conglomerates which form the base of the Carboniferous rocks of New Brunswick. I shall add here merely a few remarks on points in their physical character connected with the occurrence of plants in them.

In my recent visit I obtained specimens of *Prototaxites Logani* and other characteristic plants from the base of the Sandstones at Little Gaspé. This fact, along with the occurrence, as stated in my paper of 1863, of rhizomes of Psilophyton preserving their scalariform structure, in the upper part of the Marine Upper Silurian limestones, * proves the Flora of ✓ the Devonian rocks to have had its beginning at least in the previous geological period, and to characterize the lower as well as the upper beds of the Devonian series. In this connection I may state that, from their marine fossils, as well as their stratigraphical arrangement, Sir W. E. Logan and Mr. Billings regard the lower portions of the Gaspé Sandstones as the equivalents of the Oriskany sandstone of New York. On the other hand the great thickness of this formation, the absence of Lower Devonian fossils from its upper part, and the resemblance of the upper beds to those of the newer members of the Devonian elsewhere, render it probable that the Gaspé Sandstones, though deficient in the calcareous members of the system seen farther to the westward, represent the whole of the Devonian period.

The Gaspé sandstones, as their name imports, are predominantly arenaceous, and often coarsely so, the sandstones being frequently composed of large grains and studded with quartz pebbles. Gray and buff are prevalent colours, but red beds also occur, more especially in the upper portion. There are also interstratified shaly beds, sometimes occurring in groups of considerable thickness, and associated with fine-grained and laminated argillaceous sandstone, the whole having in many places the lithological aspect of the coal-measures. At one place, near the middle of the series, there is a bed of coal from one inch to three inches in thickness, associated with highly bituminous shales abounding in remains of plants, and also containing fragments of crustaceans and fishes (*Pterygotus*, *Ctenacanthus ?* &c). The beds connected with this coal are grey sandstones and grey and dark shales, much resembling those of the ordinary coal formation. The coal is shining and laminated, and both its roof and floor consist of laminated bituminous shale with fragments of Psilophyton. It has no true under-clay, and has been, I believe, a peaty mass of rhizomes of Psilophyton. It occurs near Tar Point, on the south side of Gaspé Bay, a place so named from the occurrence of a thick dyke of trap holding petroleum in its cavities. The coal is of considerable horizontal extent, as in its line of strike a similar bed has been discovered on the Douglas River, about four miles distant. It has not been recognized on the north side of the Bay, though we find there beds, probably on very nearly the same horizon, holding Psilophyton in situ.

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* The marine fossils of these beds have been determined by Mr. Billings. They are Upper Silurian with an intermixture of Lower Devonian in the upper part.

As an illustration of one of the groups of shaly beds, and of the occurrence of roots of Psilophyton, I may give the following sectional list of beds seen near "Watering Brook," on the north shore of the Bay. The order is descending:

	Ft.	In.
1. Grey sandstones and reddish pebbly sandstone of great thickness......		
2. Bright red shale	8	0
3. Grey shales with stems of *Psilophyton*, very abundant but badly preserved........	0	5
4. Grey incoherent clay, slicken-sided, and with many Rhizomes and roots of *Psilophyton*	0	3
5. Hard grey clay or shale with fragments and roots of *Psilophyton*........	4	0
6. Red shale........	8	0
7. Grey and reddish crumbling sandstone........		

Groups of beds similar to the above, but frequently much more rich in fossils, occur in many parts of the section, and evidently include fossil soils of the nature of under-clays, on which little else appears to have grown than a dense herbage of Psilophyton, along with plants of the genus *Arthrostigma.*

In addition to these shaly groups, there are numerous examples of beds of shale of small thickness included in coarse sandstones, and these beds often occur in detached fragments, as if the remnants of more continuous layers partially removed by currents of water. It is deserving of notice that nearly all these patches of shale are interlaced with roots or stems of Psilophyton, which sometimes project beyond their limits into the sandstone, as if the vegetable fibres had preserved the clay from removal. In short, these lines of patches of shale seem to be remnants of soils on which Psilophyton has flourished abundantly, and which have been partially swept away by the currents which deposited the sand. Some of the smaller patches may even be fragments of tough swamp soils interwoven with roots, drifted by the agency of the waves or possibly by ice; such masses are often moved in this way on the borders of modern swamps on the sea-coast.

In the sandstones themselves there are great quantities of drifted plants, principally fragments of Psilophyton, which are sometimes matted together, as if they had drifted in peaty sods, in other cases scattered loosely over the surfaces, and often in very small fragments. The sandstones also contain large drifted trunks and stumps of Prototaxites.

In the coarser sandstones there are numerous bony spines of large fishes (*Machœracanthus*), and in some of the finer beds spines and bony plates of smaller fishes, apparently of the genera *Coccosteus*, *Ctenacanthus* and *Leptacanthus*. In one of these beds my assistant, Mr. Kennedy, was so fortunate as to find a nearly perfect specimen of *Cephalaspis*, the first found in America, and a new species.*

Some of the finer beds also hold shells of Lingula, and lamellibranchiate shells of the genus *Modiomorpha* of Hall. It is a curious point of coincidence of the Gaspé sandstones with the old red sandstone of Scotland, that there are in some of the dark shales containing these shells and also fragments of plants, clusters of rounded bodies of the nature of the *Parka decipiens* of Forfarshire, though of smaller size than the Scottish specimens. When best preserved they appear as flattened globes with a depression in the centre of each and laid close together in one plane. They are most frequently attached to loose valves of bivalve shells. They must have been soft bodies covered with a tough smooth membrane, and were probably the ova of mollusks or crustaceans. Of the latter, fragments referable to *Dithyrocaris*, *Eurypterus*, *Pterygotus*, *Ceriatocaris* and *Beyrichia* occur in these beds.

Prof. Hall has kindly compared the molluscous remains with those of the Devonian of New York. He does not profess to give a conclusive judgment on them, but states that their aspect is that of the Hamilton group.

The only remaining point connected with local Geology to which I shall allude in these introductory remarks, is the admirable facilities afforded by the Gaspé coast both for ascertaining the true geological relations of the beds, and for studying the Devonian plants, as distinctly exposed on large surfaces of rock. On the coast of the River St. Lawrence, at Cape Rozier and its vicinity, the Lower Silurian rocks of the Quebec Group are well exposed, and are overlaid unconformably by the massive Upper Silurian limestones of Cape Gaspé, which rise into cliffs 600 feet in height, and can be seen filled with their characteristic fossils on both sides of the Cape.

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* Described by Mr. H. Woodward in the Geological Magazine (1871) as *Cephalaspis Dawsoni*.

Resting upon these, and dipping at high angles toward Gaspé Bay, are the Devonian sandstones, which are exposed in rugged cliffs slightly oblique to their line of strike, along a coast-line of ten miles in length, to the head of the Bay. On the opposite side of the Bay they reappear; and, thrown into slight undulations by three anticlinal curves, occupy a line of coast fifteen miles in length. The perfect manner in which the plant-bearing beds are exposed in these fine natural sections may serve to account for the completeness with which the forms and habits of growth of the more abundant species can be described in the following pages.

It will be necessary, before closing these introductory remarks, to state the reasons which have induced me to suggest in the following pages the use of the term "ERIAN," as equivalent to "Devonian," for the great system of formations intervening between the Upper Silurian and the Lower Carboniferous in America. I have been induced to adopt this course by the following considerations: 1. The great area of undisturbed and unaltered rocks of this age, including a thickness in some places of 18,000 feet, and extending from east to west through the northern states of the Union and Western Canada for nearly 700 miles, while it spreads from north to south from the northern part of Michigan far into the middle states, is undoubtedly the most important Devonian area now known to geologists. 2. This area has been taken by all American geologists as their typical Devonian region. It is rich in fossils, and these have been thoroughly studied and admirably illustrated by the New York and Canadian Surveys. 3. The rocks of this area surround the basin of Lake Erie and were named in the original reports of the New York Survey the "*Erie Division.*" 4. Great difficulties have been experienced in the classification of the European Devonian, and the uncertainties thus arising have tended to throw doubt on the results obtained in America in circumstances in which such difficulties do not occur.

These reasons are, I think, sufficient to warrant me in holding the great *Erie Division* of the New York geologists as the typical representative of the rocks deposited between the close of the Upper Silurian and the beginning of the Carboniferous period, and to use the term Erian as the designation of this great series of deposits as developed in America, in so far at least as their flora is concerned. In doing so, I do not wish to commit to the use of this term the officers of the Survey of Canada, or to introduce a new name merely for the sake of novelty; but I hope to keep before the minds of geologists the caution that they should not measure the Erian formations of America, or the fossils which they contain, by the comparatively depauperated representatives of this portion of the geological scale in the Devonian of Western Europe.

II. REVISION OF THE PRE-CARBONIFEROUS FLORA, WITH DESCRIPTIONS OF NEW SPECIES.

1. *Devonian or Erian Plants.*

Under this head I shall catalogue in order the several species of fossil plants which have been recognised in these beds in Canada, referring in the case of species previously described to the memoirs in which their characters have been published, and adding descriptions of new species, corrections of errors, new facts and structures recently obtained, and discussions of the nature and affinities of the several species, so as to bring the whole subject, as far as possible, up to the present state of knowledge; and also introducing such allied species from New York, Ohio and Maine as may serve to illustrate the Canadian species.

In order that distinct notions may be conveyed as to the geological horizons of the species, I may state that the typical Devonian or Erian series of Canada and New York may be divided in descending order into—1. The Chemung group, including the Chemung and Portage sandstones and shales. 2. The Hamilton group, including the Genesse, Hamilton and Marcellus shales. 3. The Corniferous limestone and its associated beds. 4. The Oriskany sandstone. As the Corniferous limestone, which is the equivalent of the Lower Carboniferous limestone in the Carboniferous period, is marine, and affords scarcely any plants, we may, as is usually done for like purposes in the Carboniferous, group it with the Oriskany under the name Lower Erian. The Hamilton rocks will then be Middle Erian, and the Chemung group Upper Erian. In the present state of our knowledge, the series may be co-ordinated with the rocks of Gaspé, New Brunswick and Maine as in the following table:—

Subdivisions.	New York and Western Canada.	Gaspé.	Southern New Brunswick.	Coast of Maine.
Upper Devonian or Erian.	Chemung Group.	Upper Sandstones. Long Cove, &c.	Mispec Group. Shale, Sandstone and Conglomerate.	Perry Sandstones
Middle Devonian or Erian.	Hamilton Group.	Middle Sandstones. Bois Brulé, Cape Oiseau, &c.	Little R. Group (including Cordaite shales and Dadoxylon Sandstone.)	
Lower Devonian or Erian.	Corniferous and Oriskany groups.	Lower Sandstones. Gaspé Basin, Little Gaspé, &c.	Lower Conglomerates, &c.	

In the following pages the subdivisions of the Devonian series will be indicated by the letters U.D., M.D., and L.D. The names of Canadian species are printed in *Small Capitals*. Allied species from New York and other parts of the United States introduced for purposes of comparison, are printed in *Italics*. As I have not copied in this Report any of the figures published in my previous papers, or the remarks there made on the localities and relations of the species, I have given references to these papers in the case of each species. In these references the initials "J. G. S." indicate the Journal of the Geological Society of London.

(*Coniferæ, &c.*)

GENUS DADOXYLON—UNGER.

1. DADOXYLON OUANGONDIANUM, Dawson.—(Pl. I, Figs. 1 to 4 & Fig. 15.)—Canadian Naturalist VI, 165; Figures 1 to 4. J.G.S. XVIII, 306. Acadian Geology, 2nd ed. 535, Fig. 185.—M.D., New Brunswick.

"Branching trunks, with distinct zones of growth, and a pith of the *Sternbergia* type. Wood-cells very large, with three to five rows of contiguous, alternate, hexagonal areoles with oval pores. Medullary rays with one to three series of cells, and as many as fourteen rows of cells superimposed on each other."

Since the publication of my former papers, several additional specimens of this tree from the St. John beds have been sliced and examined microscopically, without showing any farther peculiarities of structure. It is evidently an Araucarian Conifer, having regular hexagonal areolations in the cell walls, enclosing rounded discs in which are placed oval oblique pores resembling those of the Taxineæ. Like some similar conifers in the Carboniferous, it has a distinct Sternbergia pith. (Pl. I, Fig. 15.) It differs from the Carboniferous species of Dadoxylon in the great size of its woody fibres and the more numerous rows of pores or discs on their sides.

The specimens found at St. John, in the so-called "Dadoxylon Sandstone," are partially carbonized, and partially silicified, calcified or pyritized. The carbonaceous matter is anthracite, and in some places films of it have the lustre and appearance of graphite. When the calcified portions are acted on by a dilute acid, the carbonaceous matter can be recovered in a pure state and capable of showing the fibres and their pores under the microscope ; but in this condition the pores present a mere reticulation without any appearance of proper discs. When portions containing pyrites are submitted to the action of dilute hydrochloric acid, the pyritized parts remain and can be separated. These, seen under the microscope as opaque objects, often show the most beautiful casts of the fibres, exhibiting the discs in great perfection on their surfaces. As is often the case with other fossil woods, imperfectly preserved specimens show a tendency to radiating crystalline structures which are often curiously complicated with the radiating cracks following the medullary rays and the concentric lines of growth. Fig. 1 shows a specimen of this kind as seen in a polished transverse section.

More recently, the officers of the Geological Survey have collected at Lepreau, New Brunswick, additional specimens of this species, differing somewhat in their state of preservation from those at St. John. They are compressed and silicified, and shew the more minute structures of the woody fibres even more perfectly than the specimens previously in my possession. They exhibit the peculiar oblique arrangement of the pores which is also seen in some Carboniferous species, as well as in the wood of some Sigillariæ, and in the modern world is observed in Cycads and in Taxine conifers. They also show, better than my former specimens, the medullary rays, composed of from one to three series of cells, and with as many as fourteen cells sometimes superimposed on each other. It will be observed that this species thus occupies a position intermediate between the ordinary species of *Dadoxylon*, and those with several series of cells in the medullary rays, which Brongniart has separated to form his genus *Palæoxylon*.

No specimens which can be certainly regarded as the foliage or fruit of this species have been found. The specimens all appear to be drifted trunks, and the largest hitherto found, in so far as I am aware, was twelve inches in diameter. This specimen was collected by Mr. Matthew, and was stated to have had a cast of a Sternbergia pith no less than two and a half inches in diameter. Judging from the analogy of recent plants, this great diameter of the pith would indicate that the branches must have been few and thick, unless indeed we suppose that this feature was limited to the main stem, and that small branches of different structure have sprung in whorls from its sides.

The three following species are allied forms from New York and Ohio :

2. *Dadoxylon Halli*, Dn,—(Pl. I, Figs. 5, 6.)—J. G. S., XVIII, 306 ; Pl. XIII, Fig. 11.—M.D., New York.

" Wood-cells very large, with five rows of contiguous, alternate, hexagonal areoles. Medullary rays very frequent, and with as many as thirty rows of cells superimposed."

On this species I have no further information to offer, and merely figure a few cells for the sake of comparison. The chief difference between it and the last species is in its medullary rays, which are very frequent and composed of as many as thirty cells superimposed.

3. *Dadoxylon Newberryi*, Spec. Nov.,—(Pl. I, Figs. 7 to 9.)—M.D., Ohio.

Cells more slender than in the last species, areoles in two or three rows, with large oblique pores. Medullary rays very numerous, of about eighteen rows of narrow cells in two series.

This is a specimen of wood communicated to me by Dr. Newberry, by whom it was collected in the Hamilton Group (Middle Devonian) in Ohio. It indicates a form quite distinct from the preceding, and more nearly akin to the Carboniferous conifers.

GENUS ORMOXYLON—DN.

4.—*Ormoxylon Erianum*, G. & S. N.—(Pl. I, Figs. 10 to 14.)—M.D., New York. (Portage Group.)

Woody stems, with cells of the character of those of Dadoxylon, very thick-walled, with three rows of hexagonal areoles, having oval pores. And Medullary rays of one row of cells. Pith-cavity composed of a series of spherical chambers, separated by thick transverse cellular partitions.

The specimen from which the above characters are derived was collected by Prof. Hall in Schoharie County, New-York. At first sight it has the appearance of a stem of *Megaphyton*, with a row of circular leaf-scars, but on closer examination this appearance is found to be deceptive; the round spots being in reality casts in fine sandstone of a series of chambers, constituting a pith-cavity, and enclosed in a flattened carbonized stem. Before being flattened, the stem with this singular medullary cylinder must have borne some resemblance to the shell of an *Ormoceras*, a circumstance which has suggested a name for the genus. The wood of the specimen being carbonized and compressed, unfortunately retains its structure very imperfectly. With some difficulty, however, I was enabled to obtain shreds of the wood showing the tissues represented in the figures, though the general arrangement of these tissues could not be made out any farther than that the cells were arranged in radiating rows, and that there were probably rings of growth. The specimen preserved no external markings and was evidently decorticated. It must have been about two inches at the least in diameter, independently of the bark.

The character of the pith suggests affinities with *Calamodendron*, and shows that the plant must have borne on its nodes verticils of leaves or branchlets, but the structure of the wood is distinct from that of Calamodendron, and similar to that of Conifers. It is too dense and thick-walled for that of *Sigillaria*. The plant therefore stands by itself, and apparently occupies a place between *Calamodendron* and *Dadoxylon*, but nearer to the latter.

For comparison I have figured one of the pith-diaphragms of the modern *Cecropia peltata*, (Fig. 16.), and a section of the pith of *Dadoxylon Ouangondianum*. (Fig. 15.) ; also the pith of a Carboniferous Dadoxylon. (Fig. 17.) It is evident that the arrangement of the parts in the Erian *Dadoxylon* has some points of resemblance to that in the present species, while that from the Carboniferous also resembles it, though less closely. The present species is thus, in so far as its pith is concerned, a true Sternbergia, but with very distinct and very thick diaphragms, in the former respect approaching to the pith of *Calamodendron*, but without its vertical striation on the surface of the pith cylinder, a circumstance which indicates an arrangement of the woody wedges more akin to that of *Dadoxylon* or *Sigillaria* than to that of *Calamodendron*.

It is further to be observed that this species agrees with *Calamodendron* in having the diaphragms incomplete or perforated in the middle, so as to be capable of freely admitting sand into the interior, As shown in the figure, however, this was also the case with *Dadoxylon Ouangondianum*, and possibly with some of the *Sigillariæ*, into the pith-cavity of which in like manner sand has penetrated, so as to produce casts of the pith in the form of *Sternbergiæ*.

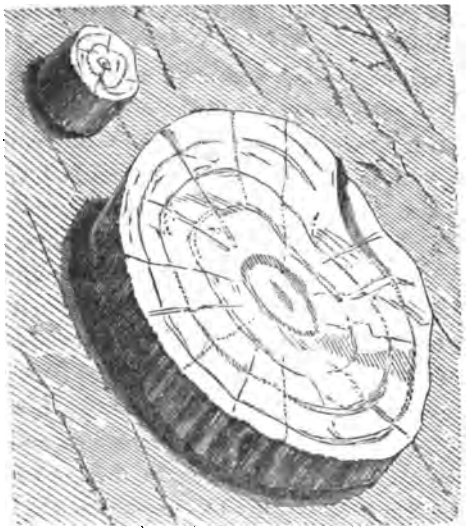
GENUS PROTOTAXITES—DN.

5.—PROTOTAXITES LOGANI,—Dn. (Pl. II, Figs. 18 to 27.)—J. G. S. XV, 484; Fig. 4. Report of Geological Survey of Canada, 401; Fig. 430.—L. & M.D., Canada.

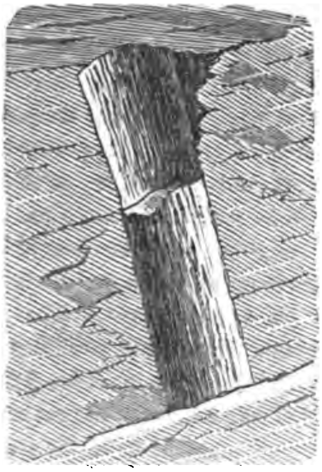
> "*Woody and branching trunks, with concentric rings of growth and medullary rays. Cells of pleurenchyma not in regular lines, cylindrical, thick-walled, with a double series of spiral fibres. Discs or bordered pores few, circular and indistinct. The specimens are usually silicified, with the bark in a coaly state.*"

This species was described, and the genus Prototaxites established, on the evidence of specimens collected by Sir W. E. Logan, and of a trunk eighteen inches in diameter observed by me in Gaspé on my first visit. In my more recent visit, I was so fortunate as to find two additional trunks imbedded in the sandstones. One was about two feet in diameter, and with seven feet of its length exposed. The other was not less than three feet in diameter and of unknown length, only a few feet of the larger end having been uncovered. Both were prostrate and silicified. In addition to these we found at Little Gaspé, near the junction of the Gaspé sandstone with the Upper Silurian limestone, two stumps of trees of this species, with spreading roots. As they did not appear to be imbedded in an underclay, but in the ordinary sandstone, I suppose them to have been drifted stumps. They are, however, of importance as shewing the existence of these trees at the beginning of the Devonian period, and also as proving that the roots were similar in form and structure to the stem, and of woody character. Loose fragments of the silicified and carbonized wood of *Prototaxites*, recognizable by its structure under the microscope, were also found in several places, and specimens were obtained by Prof. Bell, of the Geological Survey, in places not visited by me. These facts show that these trees are by no means rare; and they occur under precisely the same conditions with the drifted trunks of Coniferous trees found in the sandstones of the coal formation. This mode of occurrence, as compared with that of *Stigmariæ*, *Lepidodendra*, &c., in the same beds, shows that the wood of *Prototaxites* must have been comparable to that of ordinary Coniferous trees in durability, lightness, and resistance to water soakage. Two of the larger trunks we found are represented in situ, in the wood-cuts.

Though all the trunks hitherto found are silicified, and dark in colour except when stained with ferruginous matters, they differ very much in their state of preservation. In some cases the wood appears as a homogeneous black cherty mass, only faintly marked with a longitudinal striation parallel to the fibres. It then presents its structures in a perfection unsurpassed by any fossil wood known to me. In other cases the infiltrated silicious matter has a granular character, and the texture is destroyed or broken up in such a manner as to resemble a coarse cellular structure.



Trunk of Prototaxites Logani, eighteen inches in diameter, and Branch, as seen in the cliff near L'Anse Brehaut, Gaspé.



Trunk of Prototaxites Logani, nearly two feet in diameter, as seen in the cliff near Little Cape Oiseau, Gaspé.

In other cases a concretionary action has been established, whereby circular radiating spots have been produced, interfering with the structure; and in some instances this goes so far as to give the whole mass a sort of oolitic appearance. (Fig. 23.)

By preparing and comparing with each other a large number of slices, I have been able to recognize, under all these different states of preservation, the same structures originally described by me in the paper above cited. All present cylindrical woody fibres, marked with irregular spiral lines, and indications, perhaps illusory, of small round pores placed at unequal intervals. The woody fibres are of great length, but not closely in contact with each other, giving to the wood a lax appearance, like that in very young Coniferous stems. The fibres are not placed in regular radiating series, but are divided into wedges by radiating bands representing the medullary rays, and there are distinct lines of growth in which the fibres are of smaller diameter than elsewhere. I figure some of these appearances as presented in the specimens more recently obtained.*

With the exception of the lines of growth, I have failed to observe any change of structure in passing from the circumference to the centre. No pith has been observed, and the bark, when present, is thin and coaly. The roots have precisely the same structure with the stems, except that the fibres appear to be a little larger, and with the walls less thickened. (Fig. 27).

In all the specimens there are evident indications of medullary rays, in radiating bands and lenticular spaces traversing the wood; but the structure of the rays has perished, as one frequently observes in old and weathered trunks of modern trees. This would either indicate that the medullary rays were lax and perishable, or that all the specimens have been much decayed before fossilization. (Figs. 20, 21, 22, 25).

In one instance a large branch was observed to be given off, and on other trunks knots representing the attachment of small lateral branches, like those of ordinary pines, were found. The most remarkable external marking consists in certain transverse swellings which give to the trunk an irregularly articulated appearance (Fig. 19). These swellings are connected with a gnarled appearance of the external layers of the wood, but the internal layers appear smooth, as if the structure supervened in an aged condition of the trunk. Two explanations of it occur to me:—(1.) The swellings may mark lines from which whorls of small branches were given off in sufficient number to cause an irregularity of growth in the layers of wood covering the remains of these branches. This appearance may be observed in stems of modern trees giving off many branches at one level. (2.) The old trunks may have produced rings of aerial roots; perhaps after their bases were partially buried under sediment or accumulations of vegetable soil. In some cases holes or depressions occur along the course of the swellings, which may mark the points of attachment of the branches or roots referred to (Fig. 19 a).

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* In some of the more perfect specimens the fibres appear as if connected with each other by fine reticulations or by the dark bars of the thickened walls passing from one to another. This curious appearance it is difficult to explain. It may either depend on the state of preservation of the specimens or on some peculiarity of structure at present unknown to me.

That Prototaxites was essentially distinct from any other known tree of the Palæozoic Period is obvious; but in the absence of all knowledge of its foliage and fructification, any attempt to divine its affinities must be merely conjectural. Its want of proper vascular tissue, along with its dense woody structure and regular exogenous growth, ally it to conifers; and among these its spirally marked fibres approach more nearly to those of the *Taxineæ* than to any other tribe. Among Palæozoic plants, its structure more nearly resembles that of the wood to which I have given the name of *Nematoxylon*, than any other type. Indeed this might be placed with Prototaxites, but for the absence of any evidence of exogenous growth in the former. Prototaxites may also be compared with *Aporoxylon* of Unger, but it differs in several essential particulars, though both may be regarded as prototypal conifers. Among more recent fossil species, the tertiary genus *Spiropitys* of Goeppert presents some distant points of resemblance.*

It is perhaps worthy of notice that the plant recently described by Mr. Hincks † (*Eophyton explanatum*), from the Lower Arenig rocks of St. David's, has a tissue of uniform cylindrical cells resembling those of Prototaxites or *Nematoxylon*. It may have been a root or small branch of a tree of this description. In specimens from the Ludlow of England kindly shown to me by Mr. Etheridge of the Geological Survey of Great Britain, I found fragments of wood with the structure of *Prototaxites*.

Prototaxites is the oldest exogenous plant at present known to us, and the type is as yet confined to the Lower and Middle Devonian. It was contemporary with *Dadoxylon* in the latter of these periods, but is structurally as widely separated from that genus as from modern Taxine and

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* Mr. Carruthers has kindly pointed out to me some structural points in which this remarkable plant resembles Algae of the family *Codiæ*, the long tubes traversing which he compares with the cells of *Prototaxites*. For the reasons stated in the text, however, I cannot accept this as an indication of true affinity, and must believe the plant to have been a terrestrial tree exogenous in its mode of growth. The high botanical skill of Mr. Carruthers, however, renders it important to state his views, in the present imperfect state of our knowledge of this truly wonderful plant.

† Geological Magazine, Dec., 1869. See also infra, §III. 4.

Araucarian trees. If the type of *Dadoxylon* was introduced in the Middle Devonian, that of *Prototaxites* may then have been verging on extinction; and should forests of the Silurian period become known to us, we may hope to find in them additional species of *Prototaxites*. In the meantime it is certain that no species of fossil tree hitherto described presents histological features more primitive in aspect, and more remote from existing forms of vegetation than *Prototaxites*. In this respect it presents a marked contrast to *Dadoxylon*, and also to the contemporary acrogenous plants, whose structures, in so far as known, are almost precisely similar to those of their modern representatives.

GENUS NEMATOXYLON.—DN.

6. NEMATOXYLON CRASSUM, Dn.—(Pl. XI, Fig. 137.)—J. G. S., XIX, 366; Pl. XIX, Fig. 24.—M.D., Gaspé.

"Fragments of wood with a smooth thin bark, and a tissue wholly composed of elongated cylindrical cells with irregular pores or markings. No pith, medullary rays, or rings of growth."

7. NEMATOXYLON TENUE, Dn. (Pl. XI, Fig. 135-6.)— Ibid. 467; Pl. XVIII, Fig. 23.—M.D., Gaspé.

" Slender stems with thick coaly bark, and woody fibres of much smaller diameter than in the last species, and marked with minute dots."

I place these plants here, simply because of the resemblance of their tissues to those of *Prototaxites*, with which it is possible that they may have had some connection, being, perhaps, stems or slender roots of similar species of smaller size. No additional specimens have been obtained, since the publication of my paper above cited, which would indicate that specimens of these plants are rare at Gaspé; and they have not been found elsewhere. The original specimens were collected by Mr. Bell of the Geological Survey.

GENUS APOROXYLON.—UNGER.

8. APOROXYLON, sp.—J. G. S., XVIII and XIX.—U.D., Maine, New York.

The plant originally described by Unger as *Aporoxylon primigenium* * and referred by him to Coniferæ, may have been more nearly allied to *Prototaxites* than other described forms. It differs principally in the regular arrangement of the cells in radiating series and in their want of spiral structure. It would be difficult to distinguish this genus in obscure or badly preserved fragments, from *Prototaxites* on the one hand or *Dadoxylon* on the other. For this reason, in my former paper, I placed with some diffidence in the genus *Aporoxylon* certain fragments from New York and from Maine which presented at least the negative characters of the genus. I have not as yet been able to obtain any further specimens enabling me to be more confident on the subject.

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* Palæontologie des Thuringer Waldes, 1836.

CASTS OF PITH-CYLINDERS.

9. STERNBERGIA. Sp.—(Pl. III, Figs. 28, 29.)

These transversely marked casts of pith-cylinders are now known to have belonged to trees of several different genera, *e. g. Dadoxylon, Sigillaria, Lepidodendron, Leptophleum.* I figured in my paper of 1861, and more recently in Acadian Geology, 2nd edition, the Sternbergia pith of *Dadoxylon Ouangondianum*, found in the interior of the calcified stem. In my paper of 1862 (J. G. S., XVIII), I showed that *Leptophleum rhombicum* has a similar pith. I have since obtained specimens collected by Mr. Matthew at St. John, and by Mr. Weston at Lepreau, showing similar casts, entirely denuded of the wood in which they were no doubt at one time enclosed. To what plants they belonged I do not know, but they sufficiently resemble the pith of *Dadoxylon Ouangondianum* to render it possible that they represent trunks of that species which have perished by decay. They may however have belonged to stems of *Leptophleum.*

(*Sigillariæ.*)

GENUS SIGILLARIA.—BRONG.

10. SIGILLARIA PALPEBRA, DN.—J. G. S., XVIII, 307 ; Pl. XIII, Fig. 12.—M.D., St. John, New Brunswick.

" Ribs narrow, about a quarter of an inch in width. Leaf-scars transversely acuminate, small. "

11. *Sigillaria Vanuxemii*, Goeppert.—Flora Silurisch, &c., p. 546. J. G. S., XVIII, 307 ; Pl. XII, Fig. 7.—U. D., Oswego, New York.

" Areoles hexagonal, rather longer than broad. Vascular scars indistinct, apparently two in each areole. Bark thick. Ligneous surface obscurely ribbed, with small elongated scars in the furrows. Woody axis sulcated longitudinally; its diameter equal to one-fourth that of the stem. There are about twelve rows of areoles on a stem half an inch in diameter."

12. *Sigillaria simplicitas*, Vanuxem.—Report Geology of New York, p 190, Fig. 54.—J. G. S., XVIII, 308.—U.D., & M.D., New York.

"Ligneous surface with narrow, slightly rugose elevated ribs, about a quarter of an inch wide, in a stem five inches in diameter. Leaf-scars indistinct."

(*Syringodendron gracile*, Dn.—J. G. S., XVIII, 308; Pl. XIII, Fig. 14.—M.D., Akron, Ohio. It is probable that the beds from which this plant was obtained may be Lower Carboniferous.)

To the above I have no new species to add, nor have I any additional facts to communicate. It may be observed that of the above species, *S. Vanuxemii* represents the group of ribless Sigillariæ to which *S. elegans* of the coal measures belongs. The other two species are predecessors of the ordinary ribbed Sigillariæ of the Carboniferous. From the paucity of specimens of Sigillariæ it would seem either that these plants were rare in the Devonian period, or that the localities hitherto explored were exceptionally unfavourable to their growth or preservation. In Europe, Devonian Sigillariæ would seem to be still more rare, even if we regard *S. Hausmanniana* of the lower Devonian of Sweden as a good species, which, I confess, appears to me doubtful.

All of the above species, with one exception, seem to have been of small size, a remark which also applies to many of the Devonian Stigmariæ, the roots of these trees.

Roots of Sigillariæ.

13. Stigmaria perlata, N. S.—(Pl. III, Fig. 32.)—J. G. S., XVIII, 309.—M.D., St. John, New Brunswick.*

Areoles large, distinct, surrounded by a circular rim or margin; bark irregularly rugose.

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[*] I have seen in London specimens of a large stigmaroid root in some respects similar to the above species. It is from the Upper Devonian of *Kiltorcan* in Ireland, and is stated by Mr. Bailey to be the root of an apparently lepidodendroid tree, with *round* scars, and in the old stems a tendency to vertical ribs. It is labelled *Sagenaria Baileyana*, but is evidently not a Sagenaria, and of the type of the plants named by Haughton *Cyclostigma*. Some of my Devonian Stigmariæ may have belonged to similar plants. See infra under "Cyclostigma."

14. STIGMARIA AREOLATA, S. N.—(Pl. III, Fig. 33.)—M.D., Gaspé.

Scars about a line in diameter, and when traced spirally, distant from each other about one and a half times their diameter. In the specimen, which seems to be an impression, the scars are depressed and separated from each other by raised spaces, in the centre of each of which there is a slight waving furrow, giving an areolated appearance.

The specimen is a small fragment, but distinctly marked, and was obtained from one of the beds associated with the small bed of coal near Tar Point, Gaspé Bay. Its position is thus in the lowest part of the Middle Devonian. It is interesting thus to find a *Stigmaria* associated with a Devonian coal-bed, even though, as I have elsewhere stated, the greater part of this coal appears to be composed of remains of Psilophyton.

15. STIGMARIA MINUTISSIMA, S. N.—(Pl. III, Fig. 34.)—L.D., Gaspé.

The small but well-characterized fragment represented in the figure, seems to belong to a very minute Stigmaroid root, of which only small pieces have been found scattered on the surfaces of the Gaspé sandstones.

16. *Stigmaria exigua*, Dn.—(Pl. III, Fig. 30.)—J. G. S., XVIII, 308; Pl. XIII, Fig. 13.—U.D. Elmira, New York.

"Scars small, in depressed spaces, six in an inch vertically. Stem cylindrical, an inch in diameter."

It may admit of question whether this is not a branch of a species of *Cyclostigma*, rather than a *Stigmaria*.

17. *Stigmaria pusilla*, Dn.—(Pl. III, Fig. 31.)—J. G. S., XIX, 460; Pl. XVII, Fig. 8.—U. D. Perry, Maine.

"Allied to S. exigua, but with larger and more distant scars, not in depressed areoles.

18. DIDYMOPHYLLUM RENIFORME, Dn.—(Pl. III, Fig. 35.)—J. G. S., XVIII, 309; Pl. XIII, Fig. 15.—M.D., New York. M.D., Gaspé.

"Areoles prominent, spirally arranged, reniform; each resembling a pair of small stigmaroid areoles attached to each other. Areoles one twentieth of an inch in transverse diameter, and about one fourth of an inch distant transversely and three eighths vertically, in a stem three fourths of an inch in diameter."

This plant, as stated in a former paper, I regard as a form of Stigmaria with rootlets in pairs, or double rootlets. The original specimens were from Prof. Hall's New York collections; but Prof. Bell has since found the species in Gaspé.

Of the above stigmaroid roots, that referred to, *S. perlata*, is of large size and has its rootlets attached, as if in situ. It must have belonged to a Sigillaria of large dimensions, or to a plant allied to the Kiltorcan Cyclostigma. It is from the Fern Ledges at St. John, in which, as yet, no stem of Sigillaria has been discovered, except somewhat obscure fragments, and that on which I founded the species *S. palpebra*. The other species of Stigmaria, noticed above, are all of small dimensions, corresponding in this respect with the slender character of the majority of the stems hitherto found in the Erian beds.

LEAVES OF SIGILLARIÆ.

19. CYPERITES, sp.—(Plate III, Figs 36 to 38).—M. D., Akron, Ohio. M.D., St John, New Brunswick. U. D., Perry, Maine.

Leaves of Sigillariæ, precisely similar to the so-called *Cyperites* of the Coal Measures, are not infrequent in the Devonian rocks of St. John, Perry and Ohio; but to what species they belong is at present unknown. I figure two species from St. John and another from Perry.

(*Calamodendreæ and Calamiteæ.*)

GENUS CALAMODENDRON.—BRONG.

20. CALAMODENDRON ANTIQUIUS, S. N.,—(Pl. III, Fig. 39.)—M. D., Lepreau, N. Brunswick.

Ribs unequal, about nine on a flattened stem half an inch wide. Articulations distinct. Flattened woody envelope about a quarter of an inch wide, on either side of the ribbed axis.

The above is a description of a specimen rather than of a species; but it implies the recognition of a new form in our Devonian rocks. Calamodendra are casts of the pith-cavities of plants of very curious structure, and as yet not well understood affinities, though probably allied to Calamites and Sigillariæ. The present and the next species were collected by Mr. Weston at Lepreau.

21. Calamodendron tenuistriatum, S. N.,—(Pl. III, Fig. 40.)—M.D., Lepreau, New Brunswick.

Surface of the pith-cast marked with numerous sharp angular striæ, crossed by slightly constricted articulations, distant from each other rather more than the diameter of the stem. Woody envelope unknown.

This specimen exhibits external markings somewhat similar to those of *C. approximatum* of the coal formation, but much more slender and delicate. It is obviously not a Calamite, but the cast of the pith of a Calamodendron.

The foregoing species of Calamodendra are casts of pith-cavities in some respects allied to *Sternbergia*. The species of the next genus are founded on plants showing their external surfaces, and of very different character, as I have elsewhere endeavored to show.*

Genus Calamites.—Suckow.

22. Calamites (*Bornia*) inornatus, Dn.—J. G. S., XVIII, 310; Pl. XVII, Fig. 56.—M. D., Cayuga L., New York. M. D., Kettle Point, Ontario. L. D., Gaspé.

"Ribs continuous, as in C. Transitionis, but flat and broad, the breadth of each being a quarter of an inch in a stem four inches in diameter. Nodes distinct, prominent in the flattened stem, owing to their greater density as compared with the internodes."

Of this remarkable species no further illustration has been obtained. If, as suggested in my description, from the great amount of coaly matter produced by it, it was a woody plant, it may possibly be a *Calamodendron* rather than a *Calamites*; but further and better-preserved specimens would be required to prove this. Schimper (Pal. Vegetale) suggests that it may be a broad-ribbed variety of the next species, but this I think scarcely possible.

23. Calamites (*Bornia*) transitionis, Goeppert.—(Pl. IV, Figs. 41 to 46).—Flora des Uebergangsgebirges. Can. Nat. vol. VI., J. G. S., XVIII, 304.—M. D., St. John, and Lepreau, New Brunswick.

The specimens obtained since my former publications on this subject, confirm my belief that this plant, as found at St. John, is identical with Goeppert's species. The very unequal size of the ribs and of the stems in a large number of specimens which I have examined, leads to the conclusion that it was a plant of considerable size and extensively branching. In one specimen of a slender branch I have found the leaves still attached to one of the nodes (Fig. 42). They were extremely long and narrow like those of *C. cistii* of the Carboniferous. I now find that the long leaves, which I formerly referred with doubt to Sternberg's *Asterophyllites longifolia*, are probably the leaves of this species, borne often on very slender branchlets. Goeppert, on the evidence of internal structure, regards this plant as intermediate between *Calamites* and *Calamodendron*. Its leaves would go far to prove that it is a true *Calamites*.

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* J. G. S., 1866, p. 134. Acadian Geology, 1869, p. 440. J. G. S. 1871.

Schimper places the two preceding species in the genus *Bornia* of Roemer (not of Sternberg), characterizing this genus by the continuous ribs, dichotomous leaves and ovate elliptic strobiles, having scales each with a scar in the centre of its exterior surface. Goeppert has also shown that the tissues of *Calamites transitionis* are somewhat intermediate between those of *Calamites* proper and *Calamodendron*. These considerations are certainly sufficient to warrant at least a sub-generic distinction. With regard to one of them, however, I do not find it to be borne out by my specimens, which show that the leaves were not bifurcate, as represented by Schimper, but simple, and of the same texture with the leaves of ordinary Calamites, and the branchlets of Equisetum. It was in studying the leaves of this plant from St. John, that I first observed the delicate *microscopic transverse striation* represented in Fig. 42 B, and which I afterwards found in the leaves of Carboniferous Calamites and of the modern *Equisetum limosum*. This peculiar marking results, in the branchlets of the modern Equisetum, from the arrangement of rows of transverse stomata or breathing pores, and no doubt shows a similar arrangement in the ancient *Calamites*. This observation, which establishes the homology between the leaves of *Calamites* and the branchlets of *Equiseta*, will be referred to farther on under *Asterophyllites*, as a means of distinguishing these plants from Calamites. I mention it now merely to indicate what, if Schimper's observation is correct, will constitute an essential difference between the St. John plant and the *C. transitionis* of Europe. Schimper, I may add, identifies this species with *C. radiatus* of Brongniart.

24. CALAMITES CANNAEFORMIS, Schlotheim.—(Pl. IV, Figs. 47, 48.)—
J. G. S., XVIII, 310.—M. D., St. John, New Brunswick.

I have examined a number of additional specimens representing this species, from the Devonian of New Brunswick, but cannot find any characters separating it from the specimens found in the Carboniferous. It was a true *Calamites*, and several of my specimens show the scars of the branchlets at the tops of the ribs. I have also specimens showing the base of the stem, terminating in an oblique blunt point, exactly as in the Carboniferous species, and showing that these plants grew in groups or stools in the manner of ordinary *Calamites* of the Coal Measures.

25. CALAMITES Sp.—(Pl. IV, Fig. 49,)—M. D., St. John, New Brunswick.

Among Prof. Hartt's collections from St. John is a fragment of an erect stem about five inches in diameter, showing one node similar to those of *C. transitionis*, but with the ribs twice as wide as in specimens of that species of the same size. The ribs are, however, very variable in the same species in *Calamites*. It has remains of woody tissue on the surface, which show obscure indications of large reticulated or multiporous vessels, similar to those of ordinary Calamites (Fig. 49 A). It may possibly indicate a distinct species, intermediate in external characters between *C. transitionis* and *C. inornatus*, or may perhaps be a variety of the latter. In any case its tissues seem to be those of an ordinary Calamite.

GENUS ANARTHROCANNA,—GOEPT.

26. *Anarthrocanna Perryana*, Dn.—J. G. S., XIX, 461; Pl. XVIII, Fig. 21.—U. D. Perry, Maine.

" Stem cylindrical, swelling slightly at the nodes; ribs flattened, about fourteen in the circumference of a stem three-fourths of an inch in diameter; ribs at the nodes apparently continuous with the decurrent verticillate (?) petioles or branchlets (?).

I place this fragment in connection with the *Calamites* with some doubt; the only specimen found being very uncertain in its relations.

(*Asterophylliteæ.*)

GENUS ASTEROPHYLLITES,—BRONG.

27. ASTEROPHYLLITES PARVULA, Dn.—Canadian Nat. VI, 168; Fig. 6.—M. D., St. John, New Brunswick.

" Branchlets slender; leaves five or six in a whorl, subulate, curving upwards, half a line to a line long; intervals equal to the length of the leaves or less; stems ribbed, with scars of verticillate branchlets at the nodes."

Only a few small fragments of this species have been added to my former collections. It seems to be very rare.

28. ASTEROPHYLLITES LATIFOLIA, Dn.—(Pl. V, Figs. 50 to 53.)—J. G. S., XVIII, 311; Pl. XIII, Fig. 17.—M. D., St. John, New Brunswick.

> "Stem somewhat slender, with enlarged nodes. Leaves oblong-lanceolate, about thirteen in a whorl, one-nerved, longer than the internodes. Length of leaves varying from one-fourth of an inch, near the ends of branches, to an inch or more. Strobiles cylindrical, with oval spore cases and narrow pointed bracts."

Numerous additional specimens of this beautiful species are in Prof. Hartt's collections. They show that the whorls of leaves were borne on branchlets attached close to each other in a pinnate manner, on a jointed, striate and apparently woody stem. With the leaves are strobiles or spikes of fructification, having whorls of narrow pointed scales apparently covering oval spore-cases. On the same surfaces are also dense leafy bodies, (Fig. 52) which I regard as the undeveloped extremities of stems or branches. All these parts are perfectly parallel to those of *Asterophyllites foliosus*, L. & H., of the Carboniferous, of which this species may be regarded as the Devonian representative, differing, however, in the number of leaves in a whorl, and slightly in the form of the leaves, and the habit of growth.

29. ASTEROPHYLLITES ACICULARIS. Dn.—(Pl. V, Figs. 54 to 57. — J. G. S., XVIII, 310; Pl. XIII, Fig. 16.—M. D., St. John, New Brunswick.

> "Stems slender, striated, thickened at the nodes, leafy. Leaves one-nerved, linear, slightly arcuate, ten to fifteen in a whorl, longer than the internodes. Length of leaves one-half to three-fourths of an inch. Strobiles small, oval, with acicular bracts."

In some of Mr. Hartt's specimens, this and the last species are associated in such a manner on the same slabs as to suggest a suspicion that they may have been portions of one species. I have failed, however, to trace any connection or intermediate gradations, and, on the other hand, there are organs of fructification associated with the present species which are quite distinct from those of the last. They are small oblong strobiles with narrow leaves or scales, and sometimes in groups of two and three together. (Figs. 55, 56.)

The specimens recently obtained show that this species was similar in its habit of growth to the last (Fig. 54), and it grew apparently in the same places.

This species in its general form resembles *A. equisetiformis*, Brong., and in its fructification *A. rigidus*, Sternberg, as figured by Geinitz. I observe that Schimper has twice quoted this species, referring to the same figures and description in both cases. In page 327 he places it under *Calamocladus*, as an uncertain species of Calamite leaf. At page 349 he places it under *Annularia* as a synonym of *A. radiata*, Brong. I must dissent from both of these contradictory decisions. The species is, however, closely allied to *A. radiata*, Brong., differing principally in the form and number of the leaves. It had a stiff or rigid stem, with a stout vascular axis, and though the leaves sometimes seem united at the base, they fell off separately, and, in some beds, great numbers occur detached.

30. ASTEROPHYLITES SCUTIGERA, Dn.—(Pl. V, Figs. 58, 59).—J. G. S., XVIII, 311; Pl. XIII.—M.D., St. John, New Brunswick.

" Stems simple, elongated, attaining a diameter of half an inch, obscurely striated; bearing on the nodes whorls of round or oval scales, or bracts, which at the ends of the stems are crowded into a sort of spike, while on other parts of the stems the nodes are sometimes an inch apart."

To the description of this singular species, I have nothing farther to add, except that I have larger specimens with a greater number of joints. It may have been either a sheathed species like Unger's *A. coronata*, deprived of its leaves, or a sub-aquatic stem, bearing scales instead of branches at the nodes. The singular species of Pinnularia (*P. nodosa*, infra) is found in the same beds, and may have been connected with this plant. The spikes of fruit or buds, one of which is represented in Fig. 59, also occur with this species.

31. ASTEROPHYLITES LENTA, S. N.—(Pl. V, Fig. 60.)—M.D., St. John, New Brunswick.

Stems slender, feeble, delicately striate. Leaves long, linear, one-nerved in whorls of about ten.

This species is founded on a few specimens in Prof. Hartt's collections. It is quite distinct in form and habit from any of the others, and may have been an aquatic species.

I am sorry to see that Schimper in his new and valuable work, Palæontologie Vegetale, has thrown the Asterophyllites and their allies into a state of confusion even worse than that prevailing before. He claims as-leaves of *Calamites*, certain species of *Asterophyllites*, under the name of *Calamocladus*, and transfers others to *Annularia*. This arrangement, which I regard as wholly artificial, will render necessary a note as to the affinities of the above species, one of which Schimper transfers to *Annularia* under the name "*A. Dawsonii.*"

Accidental connections of specimens and the resemblance of some stems of *Asterophyllites* to branches of *Calamites*, have led Ettinghausen, Geinitz, and others, to confound the two genera. For example Geinitz figures* the base of a Calamite with its pinnularia-like roots, under the name *Asterophyllites foliosus*, Lindley, this last being a true typical *Asterophyllites*, as figured and described by Lindley. He also figures branches and fruits of an Asterophyllites, which may be identical with Lindley's species.† Schimper unites the whole under the name *Calamocladus foliosus*, while my Devonian species above named, and which is most closely allied to *A. foliosus* of Lindley, is placed in *Annularia.* On this I have to observe that I have in my collection, and have figured in my Acadian Geology, leaves of three species of *Calamites*, in two of the species actually attached to the erect stems, and that these leaves would certainly not, by any competent botanist, be referred to *Asterophyllites.* They are narrowly linear, much elongate, thick, fleshy, and destitute of any apparent rib, being in truth perfectly similar to the branchlets of *Equisetum*, except in wanting sheaths, a deficiency which the stem of the Calamites also exhibits, and they are as broad at the base as elsewhere.‡ On the other hand the leaves of *Asterophyllites* are comparatively broad and flat, and pointed at both ends, and have a distinct midrib; and they are borne on pinnate branches, which is never, in so far as I am aware, the case with those of *Calamites.* With regard to *Annularia*, I hold to the original diagnosis that the leaves in each verticil are of unequal length and united at the base. In addition to this, they have slender stems, and were probably floating leaves, while the Asterophyllites have rigid stems. *Annularia sphenophylloides* of Unger, and *A. laxa* of this paper, are true Annulariæ. *Asterophyllites latifolia* of this paper, and *A. foliosa* of Lindley, are true typical Asterophyllites. The leaves of *Calamites transitionis*, as figured in this paper, and those of

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* Coal Flora of Saxony, Pl. XV. † Ib. Pl. XVI.

‡ As previously stated, the miscroscopic examination of Calamite leaves shows the same structure of rows of transverse striæ observed in modern Equiseta, and to which nothing similar exists in Asterophyllites. I have verified this both in Carboniferous and Devonian species. The leaves of Calamites were in reality homologous with the branchlets of *Equiseta*, and were angled and brittle, so that they readily break in pieces, which accounts for their infrequent preservation. When flattened they seem to have an obscure midrib produced either by the angles of the surface or by the vascular axis of the leaf; but when well preserved they always show the transverse striation. (See Pl. IV, Fig. 42 b.)

C. Suckovii and *C. cistii*, as figured in my Acadian Geology, represent the foliage of Calamites. Any one who will take the trouble to compare the figures referred to, will readily comprehend the three generic names as used in this paper, and, as I believe, in strict accordance with the natural affinities of the species.

With regard to the suggestion of Brongniart that some *Asterophyllites* may be leaves and branches of *Calamodendron*, holding, as he does, and as the writer does, that *Calamodendron* is essentially distinct from *Calamites*, this does not affect the question. There is, however, no evidence as yet known to me sufficient to connect the two genera.

GENUS ANNULARIA—BRONG.

32. ANNULARIA LAXA, S.N.,—(Pl. VI, Figs. 64 to 69.)—M.D., Gaspé.

Stems slender, tortuous, with whorls of eight to twelve leaves at long intervals. Leaves long, linear, one-nerved, narrowing toward the point and united at the base by a broad membrane.

When Sir William Logan explored the Gaspé Cliffs in 1843, he observed on the surfaces of slabs of sandstone, singular stellar markings of unknown nature. On my first visit to Gaspé I endeavoured to obtain better specimens, but without success. Last summer, by excavating in some of the beds containing these impressions, and carefully washing the muddy surfaces of the slabs, we succeeded in obtaining specimens which threw some light on the nature of the plant, though its affinities may still be regarded as doubtful. It consists of slender stems, straggling over the surfaces of the beds and usually very obscure. At intervals these are surrounded by a carbonaceous film, from which radiate the leaves. These, when well preserved, have a distinct raised carbonaceous midrib, which must have been of a woody nature, though apparently flexible at the extremity. The margins of the leaves have not left very distinct impressions, and this with the quantity of carbon remaining, and the relief of the ribs, suggests the idea that they may have been thick and fleshy, or perhaps provided with air cells for floating. In some specimens the ends of the leaves are curled in a circinate manner, which may indicate their mode of vernation, but on the other hand may be accidental.

Brongniart supposes that the typical *Annulariæ* were floating plants, and this would certainly seem to have been the nature of the present species.*

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* My friend Mr. Carruthers, on examining these specimens, doubts as to the propriety of placing them in the genus Annularia, on the ground that they rather appear to be floating

I think it probable that the singular stellate objects represented in Fig. 70 have had some connection with this plant. They are perhaps its roots or possibly whorls of leaves imbedded without compression in mixed sand and mud. They are thick and massive, and penetrate the thickness of the beds in which they are contained.

The objects represented in Figs. 71, 72, are also of a radiating character and may have had a similar origin. They resemble the Cauda-galli fucoid (Spirophyton), but are apparently radiating roots or leaves (Pl. VI. Figs. 71, 72).

On the same slabs with *Annularia laxa* are numerous oval discoid bodies with a papilla or protuberance in the centre. They are smooth, thin and carbonaceous, and show no markings, except a few minute raised points near the margin. They may be flattened carpolites or peltate scales of some strobile; but they appear too thin to be explained in these ways. I can scarcely suppose that they have any connection with *Annularia laxa*, but mention them here, as they occur associated with that plant (Fig 73.)

GENUS SPHENOPHYLLUM—BRONG.

33. SPHENOPHYLLUM ANTIQUUM, Dn.—(Pl. VI, Figs. 61, 62.)—Canad. Nat., VI, Pl. 170, Fig. 7. J. G. S., XVIII, 312.—M.D., St. John, New Brunswick.

> "Leaflets cuneate, one-eighth of an inch wide at the apex, and less than one-fourth of an inch long. Nerves three, bifurcating equally near the base, the divisions terminating at the apices of six obtuse, acuminate teeth. About eight leaves in a whorl."

This sole Devonian representative of its genus appears to have been very rare, as I have not been able to obtain any specimens additional to those referred to in the papers cited above. The specimen figured in Fig. 61 shows the arrangement of the leaves but not the venation, and is smaller than the detached leaf represented in Fig. 62.

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whorls of leaves attached to each other by horizontal branches, or peltate leaves deeply cut at the edges. I had myself originally labelled them with a new provisional name; but subsequently feeling that they might come under the technical definition of Annularia, the other species of which were probably also floating leaves, and being reluctant to multiply generic names, I decided to retain them in Annularia.

ROOTS OF ASTEROPHYLLITEÆ, &c.

34. **PINNULARIA DISPALANS**, Dn.—(Pl. VII, Figs. 74 to 76.)—J. G. S., XVIII, 312; Pl. XIII, Fig. 22.—M.D., St. John, New Brunswick.

" Smooth slender stems, producing nearly at right angles long branchlets, some of which produce secondary branchlets in a pinnate manner. Stem and branches having a slender vascular axis."

Specimens in Prof. Hartt's collection shew delicate longitudinal striation, also areoles from which branchlets or rootlets have been broken off. They also show well the manner of the ramification of the central axis into the branches. I have no doubt that this Pinnularia was a cylindrical branching root, probably of *Asterophyllites*, *Sphenophyllum* or *Calamites*, with a slender vascular axis surrounded with a thick cellular coating. The two following species are distinct from the present, but probably also roots.

35. **PINNULARIA ELONGATA.** S. N.—(Pl. VII, Fig. 77.)—M.D., St. John, New Brunswick.

Stem slender, striate, branches few, long and slender, given off at an angle of about 75°.

36. **PINNULARIA NODOSA.** S. N.—(Pl. VII, Fig. 78.)—M.D., St. John, New Brunswick.

Stem straight, with alternate branches at right angles. The branches expand at intervals into obscure lobes.

This species is found in the same beds with *Calamites* and *Asterophyllites scutigera.* It was probably a root furnished with tuberous expansions, which are, however, very obscure.

(*Lycopodiaceæ.*)

GENUS LEPIDODENDRON—STERNB.

37. **LEPIDODENDRON GASPIANUM**, Dawson.—(Pl. VIII, Figs. 82 to 84.) —J. G. S., XV, 483; Fig. 3. Ib. XVIII, 313; Pl. XIV & XVII. —M.D., Gaspé. M. & U.D., New York. M.D., St. John.

Areoles contiguous, elliptic, with central leaf-scar; leaves thick at base, acicular, slightly ascending and curving downwards, short? Strobiles small, lateral? Branches slender, straight and very uniform in thickness. Areoles prominent in decorticated stems.

My explorations of last summer prove this widely distributed Devonian plant to be rare in the Gaspé sandstones. Only a few drifted specimens were found, though as some of these had their leaves attached, they were probably not derived from very distant localities. Attached to one of the specimens was a small strobile, too obscure to shew its characters distinctly, but sufficient to indicate the general form of the fructification, which was not before known. (Fig. 84).

38. *Lepidodendron Chemungense*, Hall.—(Pl. VIII, Fig. 84.)—Report New York, 275. J. G.S., XVIII, 313.—U.D., Elmira, New York'

39. *Lepidodendron corrugatum*, Dn.—J. G. S., XVIII, 313 ; Pl. VII, Fig. 10.—U.D. ? M.D. ? Akron, Ohio. Also Lower Carboniferous.

I believe the beds from which this species was obtained at Akron, Ohio, are now regarded as Lower Carboniferous, a conclusion which I suggested in the paper above cited, in consequence of this species being so characteristic of the Lower Carboniferous in Nova Scotia.

40. LEPIDODENDRON PRIMÆVUM, Rogers, (? If L. Veltheimianum, Goeppt.)—Report Pennsylvania, II, 828.—M.D., Pennsylvania. U.D. ?, Kettle Pt. Ontario.

This is evidently a Lepidodendron quite distinct from L. Gaspianum; but all the specimens I have met with are very obscure in their markings.

GENUS LYCOPODITES—BRONG.

41. *Lycopodites Richardsoni*, Dn.—(Pl. VII, Fig. 81.)—Canad. Nat. VI, 179, Fig. 10. J. G. S., XVIII, 314. Ib. XIX, 461, Pl. XVIII, Fig. 112.—U.D., Perry, Maine. Also recently found by Prof. Hall, in Upper Devonian beds at Montrose, Pennsylvania.

" Stem slender, tortuous, dichotomous ; barren branches with short erect or recurved leaves, apparently in two ranks ; fertile branches lateral, one-sided, in the form of sessile strobiles. These strobiles are the Lepidostrobus Richardsoni of my former papers."

This is a plant of very slender and probably herbaceous habit, the branches looking almost like Graptolites. It bears strobiles of comparatively large size, in rows on the side of the stem and with strong scales standing at right angles to the branches. The figure referred to above in J. G. S. XIX, well represents these points.

42. LYCOPODITES MATTHEWI, Dn.—(Pl. VIII, Figs. 85 to 87.)—Canad. Nat. VI.—M.D., St. John, New Brunswick.

" Leaflets one-veined, narrowly oval, acuminate, one-tenth to one-fourth of an inch in length, somewhat loosely placed on a slender forking stem. "

Additional specimens show this to have been a more woody plant than I had at first supposed, and possibly branchlets of some slender Lepidodendron of the type of *L. acuminata* of Goeppert. (Fig. 87.)

43. *Lycopodites Vanuxemii*, Dn.—J. G. S., XVIII, 314, Pl. XVII. Also Hall's and Vanuxem's Reports on Geology of New York.—U.D., Ithica, New York.

" Stem slender with marks of fallen leaves. Leaves pinnate, contiguous, linear, about half an inch in length."

I have seen additional specimens in the collections of Prof. Hall, which show carbonaceous and apparently woody stems, having traces of fibrous structure and transverse markings externally. The leaves have evidently been in one plane and show obscure longitudinal striation but no trace of a midrib. I have no doubt that this is a land plant, but whether most nearly allied to Lycopodiaceæ or Ferns, I still entertain doubts. * It suggests to botanical observers comparisons with leaves of Cycads and even with Algæ ; but the woody character of its stem and the nerveless condition of its leaves are against these suppositions. It is, as explained in previous papers, a near ally of Goeppert's species, *L. pennæformis*.

44. *Lycopodites comosus*. Dn.—J. G. S., XIX, 462.—U. D., Perry, Maine.

" Stem short, not observed to branch, densely covered with long filiform leaves."

45. *Lepidostrobus globosus*, Dn.—J. G. S., XVIII, 314.—U.D., Perry, Maine.

" Round, or rounded oval, covered with obscure pointed scales. "

I have no further information as to the last two species.

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* In some beds of the same series there are cylindrical branches covered with minute tubercles and bearing pinnate branchlets of similar character ; I agree with Prof. Hall that these are of animal origin.

GENUS LEPTOPHLEUM—DN.

46. **LEPTOPHLEUM RHOMBICUM**, Dn.—(Pl. VIII, Figs. 88, 89.)—J. G. S., XVIII, 316, Pl. XII, Fig. 8; and XVII, Fig. 53. Ibid. XIX, 462, Pl. XVIII, Fig. 19.—M.D., Perry, Maine. M.D., Gaspé.

"Stem covered with contiguous rhombic areoles, each with a single small scar a little above its centre, and above this a very slight furrow. Decorticated stems with spiral punctiform scars in slight depressions. Bark thin. Pith-cylinder very large, with transverse markings of the character of Sternbergia."

I figure a very well marked specimen of this curious species, shewing the external markings and the internal Sternbergia structure.

GENUS LEPIDOPHLOIOS—STERNB.

47. **LEPIDOPHLOIOS ANTIQUUS**, S. N.—(Pl. VII, Figs. 90, 91.)—M.D., Gaspé.

Areoles very small, less than half a line in length, apparently rounded below and pointed above, with acuminate ends. Central scar indistinct, lateral ones apparently obsolete. Projections below the areoles marked with sharp vertical ridges.

I have had occasion to remark in previous papers the fact that the *Lepidodendra* and *Sigillariœ* of the Devonian are for the most part slender and delicate in their habit of growth, as compared with those of the Carboniferous and specially of the Upper Coal formation. The present species exibits the same peculiarity in the genus *Lepidophloios*, usually so large and coarse in its areolation. Species like that above described are referred by some palæo-botanists to the genus *Sigillaria*, but the internal structure of the best known species shows that they were lycopodiaceous plants allied to *Lepidodendron* and bearing *Lepidostrobi*. They have no connection with *Sigillaria*, other than a superficial resemblance in the form of the areoles. Of the present species I have found only one well-characterized specimen, that figured (Fig. 90). It is about one inch in diameter, and its areoles are well preserved only on a small portion of the surface. It shows no trace of marks of cones, and was probably a young stem or branch.

Leaves, apparently of a very small species of Lepidophloios are found rarely in the shales of St. John. They may possibly belong to the present species.

GENUS PSILOPHYTON.—DN.

48. PSILOPHYTON PRINCEPS, Dn.—(Pl. IX. Pl. X, Figs. 111 to 119. Pl. XI, Figs. 127 to 129, & 133 & 134.)—J. G. S., XV, 479; Fig. 1. Ibid. XVIII, 315. Ibid. XIX, 46.—L. D., M.D., Gaspé; also Upper Silurian.

Stems branching dichotomously, and covered with interrupted ridges. Leaves rudimentary, or short, rigid and pointed; in barren stems, numerous and spirally arranged; in fertile stems and branchlets sparsely scattered or absent; in decorticated specimens represented by minute punctate scars. Young branches circinate; rhizomata cylindrical, covered with hairs or ramenta, and having circular areoles irregularly disposed, giving origin to slender cylindrical rootlets. Internal structure—an axis of scalariform vessels, surrounded by a cylinder of parenchymatous cells, and by an outer cylinder of elongated woody cells. Fructification consisting of naked oval spore-cases, borne usually in pairs on slender curved pedicels, either lateral or terminal.

This species was fully described by me in the papers above cited, from specimens obtained from the rich exposures at Gaspé Bay, and which enabled me to illustrate its parts more fully perhaps than those of any other species of so great antiquity. In the specimens I had obtained, I was able to recognize the forms of the rhizomata, stems, branches and rudimentary leaves, and also the internal structure of the stems and rhizomata, and to illustrate the remarkable resemblance of the forms and structures to those of the modern *Psilotum*. With the fructification I was less successful. The only specimen which I could regard as showing the fruit, appeared to me to present an assemblage of sessile scales. A large number of more perfect specimens obtained last summer enable me now to state that the supposed scales are really narrowly ovate sporangia; and that when mature they were borne, usually in pairs, on curved and apparently rigid petioles, in the manner represented in Figs. 102 to 108. Under the microscope these sporangia show indications of cellular structure, and appear to have been membranous in character. In some specimens dehiscence appears to have taken place by a slit in one side, and clay having entered into the interior, both walls of the spore-case can be seen. (Fig. 108.) In other instances, being flattened, they might be mistaken for scales. No spores could be observed in any of the specimens, though in some the surface was marked by slight rounded prominences, possibly the impressions of the spores within. This peculiar and very simple style of spore-case is also characteristic of *P. robustius*, and gives to Psilophyton a very distinct generic character. These naked spore-cases may be compared with those of such lycopodiaceous plants as *Psilotum*, in which the scales are rudimentary. In the manner in which they are borne they resemble those of the leafy genus *Tmesipteris*. On the other hand they might be compared with the sporocarps, or involucres as they have been called, of Rhizocarpeæ, which, however, they do not at all resemble in their manner of growth.* They might also be compared with the sporangia of the *Hymenophylla* and *Ophioglosseæ* among the ferns. In short, the species of *Psilophyton* were synthetic or generalised plants, having rhizomata resembling those of some ferns, stems having the structure of *Lycopodium*, and rudimentary leaves also resembling those of *Lycopodiaceæ*, branchlets with circinate venation like that of ferns, and Sporangia of a type quite peculiar to themselves.

Some of my lately acquired specimens also show that in the mature and fertile stems of *P. princeps* the ridges became very strongly marked, and that the scattered leaflets became hard, spinose and prominent, confirming my previously expressed opinion that the plant was somewhat rigid and woody. This character is, however, perceptible only when the plants are preserved in such a manner as to show their rotundity. When flattened, they may appear as mere fibres of carbonaceous matter, and might, in fragments, readily be mistaken for fucoids. In some instances, however, the stems and rhizomes, both of this and the next species, when perfectly flattened, show the slender scalariform axis as a carbonaceous band or line resembling the midrib of a frond. I have in previous papers referred to these various states of preservation, and the deceptive peculiarities which they present. In the present paper I have attempted to illustrate some of them in the figures.

P. PRINCEPS, Var. ornatum.—(Pl. IX, Fig. 97 to 101.)

On my late visit to Gaspé, a bed of argillaceous shaly sandstone filled with specimens of *Psilophyton* in situ, was beauifullly exposed on the north side of the bay, east of Great Cape Oiseau. Individual plants could be seen from two to three feet in length, and they appeared to have been overwhelmed when growing, all lying in one direction and being rooted in a dark shale, underlying the bed holding the stems. They presented the unusual feature of being leafy, so that fragments might have been referred to the genus *Lycopodites*. The leaves were, however, precisely of the same character with those of *P. princeps*, and their rigid spine-like nature was well shown by their projecting downward and upward into the stone from flattened stems. After the removal of the leaves, the stems exhibited rounded spots, somewhat irregularly arranged, indicating the slender bundles of vessels passing to each leaf. Being flattened the stems were more smooth than usual. No fructification was observed, and the circinate termination of many of the branches indicated that the plants were immature.

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* Dr. Hooker who kindly examined the specimens which I took to London, in 1870 appeared to be much struck with this similarity, and in the discussion of my paper entered into the points of resemblance of the fructification of Psilophyton with that of *Pilularia*; the chief point of difference being apparently in the superior development of the stem in Psilophyton.

In detached hand specimens I have no doubt that these plants would be regarded as specifically, perhaps generically, distinct from *P. princeps;* but the comparison of large numbers of nearly entire specimens forbids this conclusion, by showing such links of connection as render it impossible to draw any decided line of separation. The present form must be regarded as merely varietal, or possibly as the normal state of the immature or barren plants. To indicate the points of difference, however, I have given the varietal name *ornatum.*

Specimens referrible to this form, and showing internal structure, present no difference of appearance as compared with the ordinary type of *princeps.*

49. PSILOPHYTON ROBUSTIUS, Dn.—(Pl. XI, Figs. 130 to 132. Pl. XII. Pl. X, Fig. 121.)—L. D., M. D., Upper Silurian, Gaspé.

Stems stout, smooth or slightly furrowed longitudinally, and usually dotted with small irregular spots marking the position of ramenta or rudimentary leaves. Main stems branching irregularly and finally dichotomous. Rhizomata similar to those of the last species, but apparently smoother and less massive. Internal structure as in last species, but with a thicker vascular axis, the vessels having a tendency to arrangement in radiating series. Fructification in clusters of naked spore-cases, acuminate and somewhat falcate, borne on short dichotomous pedicels.

This species was merely indicated in former papers on the evidence of a few fragments. The discovery of a bed richly stored with the stems in situ, and bearing fructification, enables me now to complete its description. The habit of growth at once distinguishes this species, as well as its smooth and dotted surface, the absence of distinct leaves and its crowded clusters of spore-cases. Its internal structure also, though of the same general type, is notably different. It appears to have grown under precisely the same circumstances with the preceding species, and in a drifted state their fragments are often mingled together. Fragments of the stems of this species can scarcely be distinguished from leaf stalks of ferns; and I now think it possible that some of the fragments from the Devonian of New York referred to the genus *Rachiopteris*, may have belonged to it. *R. tenuistriata* and *R. pinnata* are liable to this suspicion.

The rhizomata and rootlets of this and the last species principally contribute to the contents of the remarkable Devonian *root-beds* or *underclays*, of which a great number were described by Sir W. E. Logan in his Sections of the Gaspé Sandstones. The rhizomata lie horizontally, or are entwined in a serpentine manner in the beds; and it is remarkable that great numbers often lie in one direction, as if they had been subaquatic, and their growth had been determined by a prevailing current; but this may have arisen merely from the extension of rhizomata outward from the margins of original beds or patches of the plants. In other cases they are placed confusedly in every direction. The rootlets often penetrate downwards at right angles to the beds, and are specially manifest in some sandy layers in which they sometimes resemble the Scolithus of the Potsdam Sandstone. (Pl. XIV, Fig. 166). The stems in some beds remain attached to the roots, and are bent over and flattened in one direction, like grass over which a stream of water has flowed. They have manifestly in many cases been overflowed and covered with sediment when in a growing state.

50. PSILOPHYTON ELEGANS, Dn.—(Pl. X, Figs. 122, 123.)—J. G. S., XVIII, 315; Pl. XIV & XV.—M. D., St. John, New Brunswick, M. D., Gaspé.

Stems slender, produced in tufts from thin rhizomes, bifurcating and curving at their summits. Surface smooth, with very delicate wrinkles. Fructification in groups of small, broadly oval scales, borne on the main stem below the points of bifurcation.

The original specimens on which this species was established were from St. John, and were distinguished by their tufted habit of growth, their smoothness, their small size and the fructification being apparently lateral and sessile; though this character could not be certainly ascertained. I place here specimens lately found at Gaspé having similar characters, though from the imperfect state of preservation I cannot with much confidence affirm their identity. My recent discoveries as to the fructification of *Psilophyton* render it probable that the little clusters of leaf-like bodies from St. John which I referred to the species *Annularia acuminata* are really spore-cases of this species. (See Pl. XIX.)

51. Psilophyton ? glabrum. Dn,—(Pl. VII., Fig. 79.)—J. G. S., XVIII., 315.—M. D., St John, New Brunswick.

" Smooth, flattened, bifurcating stems, two lines in width, with a slender woody axis."

I regarded this species, at the time when it was named, as of very doubtful character, in so far as its affinities with the proper species of Psilophyton are concerned. Additional specimens have not dispelled my doubts, though I still retain the name to indicate a fossil not infrequent at St. John, but of uncertain nature. The specimens are smooth, flattened, bifurcating stems, about two lines in width, with indications of a slender, woody and vascular axis. The surface is usually quite smooth, but occasionally marked with fine longitudinal striæ. They are always flattened, but from their structures must have been cylindrical and cellular with a slender axis. They resemble the larger stems of Pinnularia, but have no branchlets or indications of these, nor have I found in them any indications of leaves or other organs, though I have stems in my collection apparently well preserved and a foot in length. If not stems of a species of *Psilophyton*, they must have been roots of some plant of this genus. They much resemble certain stems with a slender axis, from the Upper Silurian, referred to farther on. Fig. 80 represents stems of *P. robustius* and a petiole of a fern, for comparison.

Genus Arthrostigma—Dn.

52. Arthrostigma gracile, G. and S. N.—(Pl. XIII.)—L.D., Gaspé.

Stems elongated, cylindrical, bifurcating, and giving off lateral branches; irregularly furrowed or ribbed longitudinally, with circular leaf-scars arranged in whorls, and bearing linear rigid leaves with circular bases. Structure apparentlg cellular, with a slender vascular axis; fructification probably in cylindrical strobiles.

The genus Cyclostigma was proposed by Haughton, in 1859,* to include plants with whorls of rounded scars found in the " old red sandstone" of Kiltorcan, in Ireland. His specimens had no leaves; but as figured, some of them show indications of a vascular axis. The plant above described might be included in the generic characters of Haughton's specimens, but is of different habit and evidently generically distinct. Its leaves and fruit indicate Lycopodiaceous affinities, but it is less close to Lepidodendron than Haughton's specimens, and perhaps connects them with Psilophyton. My specimens were found in the sandstones of both sides of Gaspé Basin, and in one bed appeared to be in situ, with irregular curving roots in the underlying bed or under-clay. The stems were found both flattened and cylindrical, the latter penetrating nearly at right angles to the beds. None of them were more than an inch in thickness, and the greater part only half an inch. The leaves were apparently rigid, and nearly at right angles to the stem, and were seen to radiate through the surrounding sandstone to the distance of more than an inch from the stem. This, with the ribbed stem and nodes with round scars, gives to the erect stem an aspect somewhat resembling that of *Calamites.* These latter plants are, however, more regularly ribbed, and never show any indication of a slender internal axis. When imperfectly preserved, the leaves resemble spines, in this according with those of *Psilophyton.* When broken off they leave rounded spots like the areoles of *Stigmaria,* but without a distinct articulation. The whorls of leaves in the flattened specimens are often oblique, but this appears to be an effect of pressure, as they are more regular in the cylindrical stems. The stems were not observed certainly to bifurcate, though there are indications of this; but on one a branch placed nearly at right angles was observed. Certain strobile-like bodies found in the same beds are probably the fruit, and it is interesting to observe that these very much resemble the spikes of fructification from Perry, described by me as *Carpolithes spicatus* (J. G. S., XVIII., 461), though at that place no stems of the present genus have been found. (Fig. 154.)

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* Trans. R. Irish Academy.

It is impossible to observe a well preserved stem of this species with its leaves attached, without a strong conviction that it represents a synthetic type, combining very diverse forms. Its articulations, ribs and verticils of leaves recall the aspect of *Calamites*, *Asterophyllites* and *Anarthrocanna.* Its circular scars have the aspect of *Stigmaria.* The structure of its stem must have been very near to that of *Psilophyton.* Its leaves are intermediate between those of that genus and *Lepidodendron.* It thus has a most antique and prototypal character, and it is remarkable that like *Prototaxites*, it seems in Gaspé to be limited in its upward range to the lower part of the Middle Devonian, as if it were then a form verging on extinction. The only plant of Carboniferous date that I can compare with it is Goeppert's *Sagenaria cyclostigma* from the "Newer Grauwacke" of Landeshutt; but this plant is very imperfectly known, and may have been of quite different character.

The flattened stems of *Arthrostigma gracile* often show distinct indications of a slender central axis, probably of scalariform vessels, though the structure is obscure.

GENUS CYCLOSTIGMA—HAUGHTON.

55. CYCLOSTIGMA DENSIFOLIUM, S. N.,—(Pl. VIII., Figs. 92 to 96.)—M.D., Gaspé.

Stems slender, covered with circular or transversely lengthened leaf-scars, spirally arranged, and bearing short curved leaves with broad bases.

The specimens on which this species is founded are fragments of stems an inch or less in diameter, found in beds associated with the small bed of coal, near Tar Point, Gaspé Bay. At first I was in doubt whether to regard these stems as belonging to *Lepidodendron* or *Stigmaria*, but the form of the scars, in connection with that of the leaves, places them in the genus Cyclostigma, as somewhat aberrant members tending towards *Lepidodendron.*[*]

GENUS CORDAITES.—UNGER. PYCHNOPHYLLUM.—BRONG.

54. CORDAITES ROBBII, Dn.—(Pl. XIV, Figs. 156 to 162.)—Can. Nat. VI. J. G. S., XVIII, 316, Pl. XIV.—M. D., St. John, New Brunswick. M. D., Cazenovia, N. Y.

" Leaves elongated, lanceolate, sometimes three inches wide and a foot in length. Veins equal and parallel. Base broad, clasping the stem, point acuminate."

These large striated leaves are so abundant in some of the shales at St. John, that the name " Cordaite shales" has been given to the beds by Mr. Matthew. I have nothing further to add to the full discussion of the affinities of this plant in the papers above cited. Like the Cordaites of the Coal-formation it sometimes has on its surface shells of Spirorbis. [†] (Fig. 161.)

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[*] Since writing the above, I have seen in London, through the kindness of Messrs. Etheridge and Carruthers, specimens from Kiltorcan, collected by Mr. Bailey, and very near to mine from Gaspé. They seem, however, to be branches of the remarkable tree referred to above under Stigmaria. At the same time, they are evidently identical with Haughton's *Cyclostigma*; which genus, I think, must stand, though founded on imperfect specimens; since the plants in question are of a very distinct type, not to be included with the Lepidodendroid or Sigillaroid trees, though they exhibit characters in some respects intermediate.

[†] These shells are attached to some of the leaves of *Cordaites Robbii* in Prof. Hartt's collections, and I have noted the same fact as occurring at Gaspé, though the specimens

55. CORDAITES ANGUSTIFOLIA, Dn.—(Pl. XIV, Fig. 163.)—Canad. Nat. VI. J. G. S., XVIII, 318.—M. D. Gaspé. M. D., St. John. M. D., New York."

" Leaves linear, much elongated, one-tenth to one-fourth of an inch broad, with delicate, equal, parallel nervures."

I have grouped under this name a number of narrow Zostera-like leaves, with delicate longitudinal striation, which abound in the Devonian beds; but what may have been their real nature I do not know. The short stem with leaves represented in Fig. 163 *b* may have belonged to this species. It is from Prof. Hall's collection.

6. CORDAITES sp.—(Pl. XIV, Fig. 164.)—M. D., St. John, New Brunswick.

A few specimens have been found at St. John, of long narrow leaves, evidently distinct from the preceding, and with parallel equal nerves. Unless merely a variety of *C. Robbii*, these may be entitled to a specific name. Another form (Fig. 165) shows an appearance of striæ between the nerves, as in *C. borassifolia*. It may represent still another species; but the specimens are few and imperfect.

57. *Cordaites* sp.—J. G. S., XVIII, 318; Pl. XVI, Fig. 59.—M. D., New York.

This may have been a stem of one of the preceding species.

58. *Cordaites flexuosus*, Dn.—J. G. S., XIX, 462; Pl. XVIII, Fig. 9. —U. D. Perry, Maine.

" Leaves lanceolate, acuminate, broad at the base; nerves numerous, parallel, somewhat sinuous and uneven."

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seem to have been mislaid. The shells from St. John are similar to the *S. carbonarius* of the Coal-formation; but the tube widens more rapidly and is smooth. They may be named *S. Erianus*.

It seems hopeless to convince Palæo-botanists that these *Spirorbes* are really shells. As long ago as 1845 I showed evidence of this, and described these shells as *Spirorbis*, and subquently I have investigated and described the microscopic structure of the shell. Yet I see that Schimper reproduces, though with doubt, the old error that these organisms are fungi (*Gyromyces ammonis* of Goeppert). I have represented the St. John specimens in Fig. 161. They appear reversed or sinistral; but when placed on a thin leaf their appearance in this respect depends on the side of the leaf exposed. Fig. 161 *b* shows the actual appearance as seen on the upper surface of the leaf.

See also Acadian Geology, p. 205, and Proceedings of Geological Society, Dec. 1865.

The leaves to which the name *Cordaites* has been given by Unger, and that of *Pychnophyllum* by Brongniart, (and some of which have been placed by botanists in the genera *Flabellaria* and *Noeggerathia*) are exceedingly abundant in the shales both of the Carboniferous and Devonian. They were parallel-veined and attached to the stem by a broad clasping base, which seems to have been readily disarticulated, as they are usually found disconnected from the stem. The aspect of the leaf suggests affinities with Endogens, but the structure of the stem, as described by Corda, with its simple cylinder of scalariform vessels destitute of medullary rays, obviously approaches to that of *Lomatofloios*, *Lepidofloios*, and *Lepidodendron*. Structurally, therefore, these plants are members of the Lepidodendroid group, generally regarded as Lycopodiaceous, though markedly distinguished by their broad parallel-veined leaves. Unger, for this reason, places them in Lycopodiaceæ; though Brongniart suggests affinities to Sigillariaceæ, which do not, however, seem so close, except, perhaps, in the resemblance of the leaves of some species to the parallel-veined leaves of *Sigillaria elegans*. I have followed Unger in placing these plants with the Lycopodiaceæ.

(*Filices.*)

GENUS CYCLOPTERIS.—BRONG.

59. CYCLOPTERIS (Archæopteris) JACKSONI, Dn.—(Pl. XV, Figs. 167 to 169.)—Canad. Nat. VI, 173; Fig. 9. J. G. S., XVIII, 319. Ib. XIX, 462; Pl. XIX, Fig. 26.—U. D., Perry, Maine. U.D., N. York M. D., St. John.

"Frond bipinnate; rachis stout and longitudinally furrowed; pinnæ alternate; pinnules obliquely obovate, imbricate, narrowed at the base, and apparently decurrent on the petiole; nerves nearly parallel, dichotomous; terminal leaflet large, broadly obovate or lobed."

A specimen recently received by the Geological Survey from Gaspé, shows pinnules which I refer to this species, on a slab which also contains a portion of a large Lepidoganoid fish, allied to *Holoptychius*. This is the first occurrence of a fern in the Gaspé beds. It is, probably, from the upper part of the series.

60. C. (*Archæopteris*) *Halliana*, Goeppert.—(Pl. XV, Fig. 170.)—Fl. Sil. 498. Hall, Report on New York, p. 275, Fig. 127. J. G. S., XVIII, 318; Pl. XVII, Figs. 54 and 55.—U. D., New York.

61. C. (*Archæopteris*) *Rogersi*, Dn.—(Pl. XV, Fig. 171.)—J. G. S., XIX, 463; Pl. XVII, Figs. 17, 18. Pl. XIX, Fig. 27.—U. D. Perry, Maine.

"Habit of growth resembling that of *Cyclopteris Jacksoni*, but the pinnules are more elongated and almost cuneate in form, also less densely placed, and with veins more nearly parallel. Stipe stout, woody, furrowed longitudinally, and marked with strong transverse bars or punctures."

A specimen, obscure in details, but which must belong to this or the previous species, occurs in Prof. Hall's collection, from Montrose, Pa., and presents the curious peculiarity of showing no less than nine petioles proceeding from a common origin, as if the plant had either been a low-growing simply pinnate fern, with its fronds in dense clusters, or had grown on a common stipe in a densely palmate manner. Perhaps the former is the more probable supposition.

62. C. (ANEIMITES) VALIDA, Dawson.—(Pl. XVI, Fig. 190.)—J.G.S. XVII, 319, Pl. XVI, Fig. 52.—M. D., St. John.

"Tripinnate; primary divisions of the rachis stout and wrinkled. Pinnæ regularly alternate. Lower pinnules nearly as broad as long, deeply and obtusely lobed, narrow and decurrent at the base; regularly diminishing in size and breadth toward the point, and the last pinnules narrowly obovate and confluent with the terminal pinnule. Nerves delicate, several times dichotomous."

63. C. (ANEIMITES) OBTUSA, Lesquereux.—Pl. XVI, Fig. 188.)—Rogers's Report on Pennsylvania, p. 854; Pl. 1, Fig. 11. J. G. S., XVIII, 319, Pl. XV, Fig. 33.—M. D., St, John, N. Brunswick.

64. C. (ANEIMITES) BOCKSHII, Goeppert. (Lesqx.)—(Pl. XVI, Fig. 187.)—Report Pennsylvania, p. 854, Pl. III.—M. D., St. John, New Brunswick. M. D., Pennsylvania.

This may be a variety of *C. obtusa*, but Lesquereux thinks it distinct, and fronds perfectly similar to those which he has figured occur at St. John.

65. CYCLOPTERIS BROWNII, Dn.—(Pl. XV, Fig. 172.)—J. G. S., XVII, 32; Pl. XII, Fig. 9. Ib. XIX, 463; Pl. XVII, Fig. 6. —U. D., Perry, Maine. Pennsylvania?

"Pinnules large, cuneate, with distant, once-forked nerves, and waved margins."

66. C. [NEPHROPTERIS] VARIA, Dn.— Pl. XVII, Figs. 201, 202.)—J. G. S., XVIII, 319 ; Pl. XV, 34.—M. D., St. John, New Brunswick.

" Pinnate [or bipinnate]. Pinnæ with a thick petiole. Pinnules decreasing in size to the terminal one, which is ovate and lobed. Pinnules oblique, and decurrent on one side. Nerves frequently dichotomous."

67. C. (NEPHROPTERIS) PROBLEMATICA, S. N.—(Pl. XV, Figs. 173, 174.)

" Pinnæ obliquely flabellate, with broad base and coarse nerves, much curved and forking twice.—M. D., St. John."

A number of detached pinnules belonging to this species have been found. At first sight they resemble small specimens of *C. Brownii*, but the general form and venation are different.

The ferns referred to the genus Cyclopteris, are probably by no means a natural assemblage. They resolve themselves somewhat roughly into two groups ;—those which, like *C. Jacksoni* and its European representative *C. Hibernica*, have ovate pinnules decurrent on the rhachis, and those which, like *C. obtusa* and *C. Brownii*, have flabellate leaves ; but no well-marked line of separation can be established between these two groups, or between either and the Carboniferous Cyclopterids.

Some of the species have been included in the genus *Noeggerathia*, but this, as originally proposed by Sternberg, and subsequently employed by Palæo-botanists on the continent of Europe, is obviously intended for the reception of very different plants. The genus *Adiantites* of Goeppert would include many of the species ; but the characters of this genus are not sufficient to distinguish it from *Cyclopteris*, and there is no evidence that any of the species were allied to the modern genus *Adiantum*. Goeppert himself has consequently abandoned the genus as applied to these plants, and includes the whole under the provisional name of *Cyclopteris*. I may add that this genus would be in no respect more objectionable than other similar genera of Palæozoic ferns, if a few species based on the round basal pinnules of Neuropterids were removed from it.

In Schimper's recent work on fossil plants, another attempt is made to classify the Cyclopterids on the basis of Ettingshausen's method. He restricts the genus Cyclopteris to a few flabellate species belonging to the Carboniferous and Permian. The greater part of the Devonian species he places in a new genus *Palæopteris*, in which he includes the very distinct types represented by *C. Jacksoni* and *C. obtusa*. This arrangement, I fear, cannot be received as either natural or convenient. The name *Palæopteris* has been pre-occupied by Geinitz for certain *trunks* of tree ferns, two of which, *P. Hartii* and *P. Acadica* occur in the Carboniferous of British America.* The genus as proposed includes two very distinct types, both highly characteristic of the Devonian, the one with closely set pinnate leaves, decurrent on the rhachis, represented by *C. Hibernica* and *C. Jacksoni*, the other with clustered pinnules petiolate or attached by a narrow base and with flabellate venation, represented by *C. obtusa* and *Bockshii*. For this last type, represented in the Lower Carboniferous by my *Cyclopteris Acadica*, I proposed long ago the generic name *Aneimites* † ; and though I observe that Schimper has proposed for other ferns the sub-generic names *Aneimioides* and *Aneimidium* I still desire to retain this name on the ground both of priority and of probably correct botanical affinity. For the other type, I must, for the reasons above stated, reject equally the names *Noeggerathia*, *Adiantites* and *Palæopteris*, and as a term seems absolutely necessary to designate these plants, I would modify Schimper's name which is well-adapted to express the fact of the antiquity of these plants, by changing it into *Archæopteris*.

I must here also correct some errors as to American species into which Schimper has fallen. My *Cyclopteris valida* he refers to two distinct genera (quoting the same figure and description in both places). At p. 402 of his work it is an *Aneimioides*, and at p. 480, it is a *Triphyllopteris*. The first is correct as to name, as the plant would go into my genus *Aneimites*, but it is placed with other ferns not allied to it, and separated from those more nearly akin to it. *Sphenopteris laxa* of Hall he also quotes in two places, in the one case identifying it correctly with *C. Halliana*, Goeppert ; in the other incorrectly with *C. Hibernica*. *Noeggerathia* (*Cyclopteris*) *obtusa* of Lesquereux he also identifies quite incorrectly with *C. Hibernica ;* and he gives *C. Jacksoni* as a synonym of *C. Halliana*, disregarding the diagnoses given in my papers,‡ from inspection of the original specimens, and which fully separate the three allied American species, *C. Halliana*, *C. Jacksoni*, and *C. Rogersi*.

Having cleared away these errors, I may now give the provisional arrangement which I would propose for this group of ferns, as follows :

Sub-genus 1st. *Archaeopteris*, Dawson. Type *A. Hibernica*. In America, *A. Halliana*, *A. Jacksoni*, *A. Rogersi*.

Sub-genus 2d. *Aneimites*, Dawson, type *A. Acadica*. In America, *A. obtusa*, *A. Bockshii*, *A. valida*. The latter connects this type with the broad-leaved Sphenopterids.

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* J. G. S., XXII, 159. † J. G. S., XVII, 5. ‡ J. G. S., XVIII & XIX.

Sub-genus 3d. *Nephropteris*, Schimper, type *N. orbicularis*, Brong. In American Devonian, *N. varia* and *N. problematica*. These are possibly basal pinnules of Neuropterid ferns.

Sub-genus 4th. *Cyclopteris* proper, Schimper. Type, *C. flabellata*, Brong. In American Devonian, *C. Brownii*.

Schimper suggests that my *Sphenopteris Hitchcockiana* (Fig. 175) may be the fructification of one of the above ferns of the genus *Archæopteris*. I regard this as quite possible, but have no direct evidence of it.

The first, second and fourth of the above sub-genera may be regarded as eminently characteristic of the Erian or Devonian period, and especially of the Upper Devonian, both in Europe and America; and by their prevalence they serve to distinguish these beds from the Carboniferous. In the Lower Carboniferous, however, such ferns as *Cyclopteris* (*Aneimites*), *Acadica*, still continue to represent in some degree these peculiar forms.

GENUS NEUROPTERIS.—BRONG.

68. NEUROPTERIS POLYMORPHA, Dn.—(Pl. XVIII.,Fig. 212.)—J. G. S., XVIII, 320; Pl. XV, Fig. 20.—M.D., St. John, New Brunswick.

> "Pinnate or bipinnate. Rachis or secondary rachis irregularly striate. Pinnules varying from round to oblong, unequally cordate at base, varying from obtuse to acute. Terminal leaflet ovate, acute, angulated or lobed. Midrib delicate, evanescent. Nervures slightly arcuate, at acute angles with the midrib."

This fern is very abundant in detached fragments in the shales of Carlton near St. John, and was described by me from these fragments. A few perfect specimens occur in the collection of Prof. Hartt, and confirm my restoration from the fragments previously studied. In the recent collections of Prof. Hartt there are some pinnæ with pinnules more elongated than the typical forms, but I regard them as merely a variety.

69. NEUROPTERIS SERRULATA, Dn.—(Pl. XVIII, Fig. 213.)—J. G. S., XVIII, 320; Fig. XV, 35.—M.D., St. John, New Brunswick.

> "Bipinnate. Rachis thin and slender. Pinnæ alternate, sparsely placed, and of few pinnules. Pinnules obovate, narrowed at base, sessile, delicately but sharply serrate, especially at the apex. Terminal leaflet rounded and lobed, scarcely serrulate. Midrib visible nearly to the apex. Pinnules about two lines in length."

This species was founded upon a few fragments from Carlton, and Mr. Hartt subsequently discovered more perfect specimens, which seemed to him to indicate that the species is really a *Pecopteris*. In this conclusion I acquiesced, and omitted this species from the list in Acadian Geology. Subsequently, however, I found, on comparing the specimens in Mr. Hartt's collection with those I had previously obtained, that there are two species, for one of which I retain the above name.

70. NEUROPTERIS RETORQUATA. S. N.—(Pl. XVII, Fig. 197.)—M.D., Lepreau, New Brunswick. Col. Geol. Survey.

Pinnules broad oblong, obtuse, curved obliquely, cordate or auriculate at base. Midrib faint, and traceable little more than half way from the base, nerves crowded, very oblique, curved, forking abou twice. Basal pinnules orbicular, or reniform, with diverging veins.

Numbers of scattered pinnules of this species occur on the surfaces of the Devonian shales at Lepreau. It is a very distinct species, allied, however, to *N. flexuosa* and *N. gigantea* of the Carboniferous. The pinnules were either somewhat thick or strongly reflexed at the margin. In these characters, as well as the form of the pinnules, it differs markedly from *N. polymorpha*, with which it is associated in the beds at Lepreau. The specimens described were collected by Mr. Weston of the Geological Survey.

71. NEUROPTERIS CRASSA, Dn.—(Pl. XVII, Fig. 200.)—Acad. Geology, p. 551.—M.D., St. John, New Brunswick.

A single pinnule is all that I have to represent this species. It was collected by Mr. Lunn of St. John, N. B.

72. NEUROPTERIS SELWYNI, S. N.—(Pl. XVII, Fig. 198.)—M.D., St. John, New Brunswick.

Pinnate. Pinnules oblong, narrow at the point, curved upward. The lower side of the base cut off obliquely, so as to form a notch between the pinnule and the petiole. Mid-rib distinct. Nerves much curved, forking once or twice.

A single specimen represents this species in Prof. Hartt's collections from St. John. I dedicate the species to the Director of the Geological Survey.

73. NEUROPTERIS, sp.—(Pl. XVII, Fig. 199.)

A few fragments in my collections from St. John represent another species resembling *N. Sorettii*, Brongt., but they are insufficient for description.

74. N. (MEGALOPTERIS) DAWSONI, Hartt.—(Pl. XVII, Figs. 191 to 194.)—Bailey's Report on New Brunswick. Acadian Geology, 2nd edition, p. 550 Fig. 193.—M.D., St. John, New Brunswick.

"Frond rugose, rhachis thick, striated, broadly winged, pinnæ alternate, very oblique, acute at apex, often an inch wide and six inches long, margin undulate ; midrib disappearing before reaching apex, veins numerous, very oblique, curved, forking thrice very obliquely."

This is one of the finest of the Devonian ferns, its pinnules being sometimes six inches in length, and at first sight reminding an observer of the Glossopterids of later rocks, though very different in their venation. The fragments in Prof. Hartt's collection appear to indicate that the fronds consisted of large oblong pinnules closely aggregated together, or attached at a very acute angle to a rachis itself broadly winged. The veins spring from a broad flat midrib at a very acute angle, and curve outward to the margin, which they meet almost at right angles. It may admit of doubt whether this fern is really a Neuropteris ; but its scattered pinnules would at once by their form and venation be referred to that genus, though the habit of growth seems to have been different ; and for this reason I have suggested the sub-generic name above.

In the species of Neuropteris the Devonian Flora approaches very nearly to that of the Carboniferous, several of the species being closely allied to common Coal formation ferns. They are, however, distinct specifically, and on the whole of a more delicate and less massive type. The principal exception to this is the remarkable species *N. Dawsoni.* This, however, manifestly presents in its venation a tendency toward *Cyclopteris*, though the form of the leaf is so different, and it is quite likely that when more fully known it will become the type of a new genus.

GENUS CALLIPTERIS.—BRONG.

75. CALLIPTERIS PILOSA, S.N.—(Pl. XVI, Fig. 189.)

Bipinnate or tripinnate. Pinnæ oblong with broad terminal leaflet, and crowded obovate obtuse decurrent pinnules, with a thick short midrib and a few forking curved veins. Frond dense and covered with very numerous microscopic hairs generally masking the venation. Fertile pinnæ with nearly round pinnules, smooth and much reflexed in the margins.

This curious fern, rather common in the Middle Devonian at St John, was described by me in Acadian Geology under the name *Sphenopteris* *pilosa.* I now refer it to Brongniart's genus *Callipteris.* Though the typical species of this genus are Permian, I believe it has representatives in the Carboniferous.

GENUS SPHENOPTERIS.—BRONG.

76. SPHENOPTERIS HOENINGHAUSI, Brong.—(Pl. XVI, Fig. 185.) —M.D., St. John, New Brunswick.

The ferns from St. John which I referred to this species are very rare, and no examples showing the venation have been found. It resembles Brongniart's species in form and dimensions.

77. SPHENOPTERIS MARGINATA, Dn.—(Pl. XVI, Fig. 184.)—J. G. S., XVIII, 321; Pl. XV, Fig. 38.—M. D., St. John, New Brunswick.

"This resembles the last species in general form, but is larger, with the pinnules round or round-ovate, divided into three or five rounded lobes, and united by a broad base to the broadly winged petiole."

This species is more abundant than the preceding, and the recent collections include specimens showing its form and venation very distinctly.

78. SPHENOPTERIS HARTTII, Dn.—(Pl. XVI, Figs. 176, 177.)—J. G.S., XVIII, 321; Pl. XVII, Fig. 32.—M.D. St. John, New Brunswick.

"Bipinnate or tripinnate. Divisions of the rachis margined. Pinnules oblique, and confluent with the margins of the petiole; bluntly and unequally lobed. Nerves few, oblique, twice-forked."

79. SPHENOPTERIS HITCHCOCKIANA, Dn.—(Pl. XV, Fig. 175.)—J. G. S., XVIII, 321; Pl. XVI, Fig. 31.—U.D., Perry, Maine.

"Stipes stout, straight, rugose, giving off slender secondary petioles, which ramify dichotomously and terminate in minute obovate leaflets."

The only perfect specimen of this species was found by Mr. Hitchcock at Perry. The suggestion of Schimper already referred to, that this species may be founded on fertile pinnules of Cyclopteris of the subgenus Archœopteris, is deserving of attention. The scattered pinnules from St. John referred to it in a former paper are, I confess, very doubtful, and in large additional suites of specimens I have not been able to ascertain any connection with a stem. They may possibly be scattered spor-cases, as suggested by Schimper.

80. SPHENOPTERIS RECURVA, Dn.—J. G. S., XIX, Pl. XIII, Figs. 7, 8.—U.D., Perry, Maine.

"Leaflets small, cuneate, terminating the divisions of a dichotomous winged petiole."

81. SPHENOPTERIS SPLENDENS, S.N.—(Pl. XVI, fig. 186.)

Tripinnate; pinnæ oblong, broader at base, with flexuous petiole, bearing six to ten rounded, lobed, confluent pinnules, each with few veins branching abruptly.

I am sorry to add another to the many species of *Sphenopteris;* but the above will not accord with any known to me. Its nearest ally is perhaps *S. fragilis*, Brong., but it is much more densely and closely constructed than that species. Its petioles and nerves seem to have been woody, and the frond thick, and in consequence it shines forth in all the metallic brilliancy of a dense graphitic film, from which circumstance I have taken its name.

GENUS HYMENOPHYLLITES.—GOEPT.

82. HYMENOPHYLLITES CURTILOBUS, Dn.—(Pl. XVI, Figs. 178, 179.) —J. G. S., XVIII, Pl. XV, Fig. 39.—M.D., St. John, New Brunswick.

"Bipinnate. Rachis slender, dichotomous, with divisions margined. Leaflets deeply cut into subequal obtuse lobes, each one-nerved, and about one-twentieth of an inch wide in ordinary specimens."

Some specimens of this species appear to show an inflection of the extremity of the pinnules, as if from fructification.

83. HYMENOPHYLLITES SUB-FURCATUS, Dn.—(Pl. XVI, Fig. 180.)—Acadian Geology, p. 552, Fig. 192, &c.—M. D., St. John, New Brunswick.

"Similar in general form to *Sphenopteris* (H.) *furcatus*, Brong., but with broader and acute divisions of the pinnæ."

84. HYMENOPYLLITES GERSDORFII, Goeppert.—(Pl. XVI, Fig. 182.) —M. D., St. John, New Brunswick.

Quite similar to Goeppert's figures.

85. HYMENOPHYLLITES OBTUSILOBUS, Goeppert.—(Pl. XVI, Fig. 183.) —M.D., St. John, New Brunswick.

Found with the preceding, which it closely resembles, except in its greater size.

86. HYMENOPHYLLITES HILDRETI, Lesquereux.—(Pl. XVI, Fig. 181.) —Rogers's Report on the Geology of Pennsylvania.—M. D., St. John, New Brunswick.

Specimens procured by Mr. Weston at Lepreau appear to belong to the above named species. Lesquereux's specimens were from beds at Kenawka Salines, which I suppose to be Devonian or Lower Carboniferous.

According to Brongniart the genus *Hymenophyllites* occurs both in the Carboniferous and Permian of Europe. Lesquereux, on the other hand, states that in Pennsylvania the genus *Hymenophyllites* is confined to the Devonian. In Nova Scotia I have described one species from Mr. Brown's collections from the coal-field of Cape Breton. It is evident, however, from the descriptions by Unger of the Devonian ferns of Thuringia, from those of Lesquereux of those of Pennsylvania, and from the list of species above given, that the genus *Hymenophyllites* and the more delicate forms of the genus *Sphenopteris* were relatively much more abundant in the Devonian than in the Carboniferous period.

It seems at present scarcely possible to effect any intelligible arrangement of these ferns in sub-genera. Schimper re-unites most of the ferns placed in the genera Hymenophyllites and Trichomanites with Sphenopteris, and gives to the former genera merely a sub-generic value. Most of the species above mentioned would go into his sub-genus *Hymenophylloides*.

GENUS ALETHOPTERIS—STERNB.

87. ALETHOPTERIS DISCREPANS, Dn.—(Pl. XVIII, Figs. 203 to 205.) —J. G. S., XVIII, 222; Pl. XV, Fig. 37.—M.D., St. John, New Brunswick.

"Bipinnate. Pinnules rather loosely placed on the secondary rachis, but connected by their decurrent lower sides, which form a sort of margin to the rachis. Midrib of each pinnule springing from its upper margin and proceeding obliquely to the middle. Nerves very fine and once-forked. Terminal leaflet broad."

This fine fern is illustrated by a number of specimens in Prof. Hartt's collections, and has also been found at Lepreau. It is evidently very variable in the form of the pinnules, in this resembling the Carboniferous *A. lonchitica*, to which it is closely allied. Some of these varietal forms as illustrated in Prof. Hartt's recent collections deserve to be figured.

88. ALETHOPTERIS INGENS, Dn.—(Pl. XVIII, Fig. 206.)—Ib.—M.D., St. John, New Brunswick.

" Pinnules more than an inch wide, and three inches or more in length, with nervures at right angles to the midrib and forking twice.

89. ALETHOPTERIS PERLEYI, Hartt.—Acad. Geol. p. 552.—M. D., St. John, New Brunswick.

" Allied to *A. serrula*, Lesq., but pinnæ wider and closer and not so long or so much united; usually tridentate; teeth acuminate, middle one sometimes emarginate; vein three-forked, sending a veinlet into each lacinia. The middle veinlet branches in the middle lacinia."

GENUS PECOPTERIS—BRONG.

90. PECOPTERIS (ASPIDITES ?) SERRULATA, Hartt.—(Pl. XVIII, Figs. 207 to 209.)—Acad. Geol. p. 553, Fig. 92.—M. D., St. John, New Brunswick.

" Tripinnate; pinnæ short, alternate, close or open, lanceolate, very oblique, situated on a rather slender rounded subflexuose rachis; pinnules small, linear lanceolate, crenulate, revolute, moderately acute, oblique, sessile, decurrent, widest at the base, open, separated from one another by a space equal to the width of a pinnule, slightly arched towards the point of pinna; longest at base of pinna, decreasing thence gradually to the apex; terminal pinnule elongated. Median nerve entering the pinnule very obliquely, flexuous, running to the apex. Nervules very few, oblique, simple, and somewhat rarely forking at the margin."

Numerous additional specimens of this species confirm Prof. Hartt's determination of its distinctness from *P. plumosa*, Brongt. It perhaps more strongly resembles Goeppert's *P. Silesiaca*; but this last has broader and more closely arranged pinnules decurrent on the petiole. It may be taken as a Devonian representative of the delicate Pecopterids of which the species above named are Carboniferous types. Mr. Hartt's specimens enable me to represent its habit of growth. Schimper quotes under this name a Carboniferous species of Lesquereux. But Lesquereux's species is *Alethopteris serrula.*

91. **Pecopteris obscura?** Lesquereux.—J. G. S., XVIII., 322.—M.D., St John, New Brunswick.

92. **Pecopteris (Aspidites?) preciosa**, Hartt.—(Pl. XVIII., Figs. 210, 211).—Acad. Geol. 353.—M.D., St. John, New Brunswick.

"Pinnæ a little larger than those of the last species, not serrated; placed nearly at right angles to the rachis, obtuse, narrow towards the extremity, suddenly widened, or almost auriculate at the lower side; mid-rib extending to the apex; nerves few, at a somewhat acute angle."

Somewhat more complete specimens in Prof. Hartt's collections show a little more of the habit of growth of this fern than was previously known. Both the pinnæ and the pinnules were placed nearly at right angles to the petioles.

93. **P. (Cyathites?) densifolia**, S. N.—(Pl. XVII, Figs. 195, 196.)—M.D., St. John, N. B.

Bi-pinnate, pinnules oblong, rounded at the ends, crowded together on a thick striated petiole. Mid-rib somewhat decurrent on the petiole, at an angle of about 45°. *Veins few, forking once, oblique. Margins of the larger pinnules somewhat undulate.*

This new species occurs in Prof. Hartt's collections from Carlton, near St. John, N.B.

Genus Trichomanites—Goept.

94. **Trichomanites filicula**, Dn.—J. G. S., XIX, 464; Pl. XVII, Figs. 12, 13.—U. D., Perry, Maine.

Pinnules slender, attached to long petioles, and bifurcating into slender points.

95. **Trichomanites**, sp.—J. G. S., XVIII, Pl. XVI, 50.—M. D., St. John, New Brunswick.

Bifurcate pinnules, extremely minute, thread-like, four to seven in each pinna.

Both of these species are founded on fragments which are of doubtful character, and may prove to be merely skeletons of fronds.

PETIOLES OF FERNS.

96 to 100. RHACHIOPTERIS, viz., (*R. pinnata*, *R. cyclopteroides*, *R. punctata*, *R. striata*, *R. tenuistriata*.)—J. G. S., Ib.

Under this generic name I have described several detached leaf-stalks of ferns, principally from New York and St. John, of which the fronds are unknown. I have nothing further to add, in respect to these, except that my recent specimens from Gaspé lead me to suspect that some of these supposed leaf-stalks may be in reality decorticated stems of Psilophyton.

Several detached leaf-stalks of ferns are in my collections from St. John, but they probably belong to some of the species above described. Though no fronds of ferns have yet been found in the Gaspé plant-beds, with the exception of the pinnæ of *Cyclopteris Jacksoni* already referred to, obscure specimens are not infrequent, which I think can be distinguished from stems of Psilophyton, and are probably petioles of ferns. One of these is figured in Pl. VII., Fig. 80a.

Two large and interesting specimens of petioles, probably of tree ferns, have recently been communicated to me by Prof. Hall. They are :

101. *Rhachiopteris gigantea.* Dn.

This is the base of a large leaf-stalk somewhat flattened. It is smooth and marked with even longitudinal depressed lines, about twenty in number, dividing the surfaces into rounded ridges. It shows no structure, but has the remains of carbonized fibres or bundles of vessels at the larger end. It is from the Hamilton group (Middle Devonian) of New York. It is three inches in diameter, and must have supported a very large frond.

102. *Rhachiopteris palmata*, Dn.

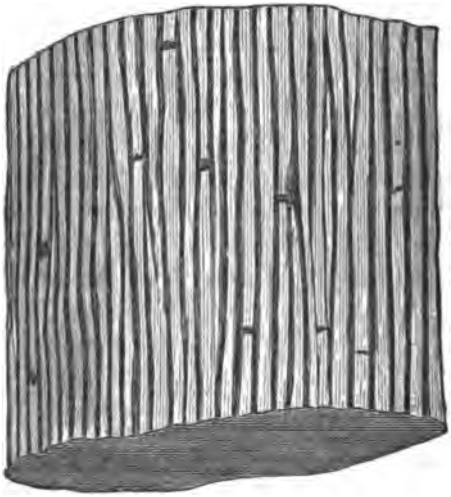
This is ten inches in length, flattened, and marked with furrows and ridges. It divides at the distal extremity in a palmate manner into five pedicels. From another specimen in Prof. Hall's collection, already referred to, I would infer that this petiole may possibly have borne fronds of the type of *Cyclopteris Rogersi.* It is from the Hamilton group (Middle Devonian,) of New York.

The number of stipes of ferns found in some of the Devonian beds is instructive, as indicating the amount of maceration which the fronds have undergone. In the Devonion also as in the Carboniferous, few fronds showing fructification occur.

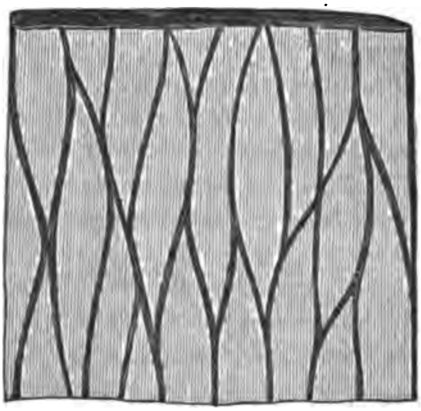
TRUNKS OF TREE FERNS.

103. *Psaronius Erianus*, S. N.—M. D., New York.

Trunk completely invested with cord-like aerial roots parallel to each other, and either closely appressed or arranged at regular intervals. Each root consisting of an outer, probably cellular, coat, with an axis of fibres and scalariform or reticulated vessels.



Psaronius Erianus. From a Specimen from New York.
(Exterior with aerial roots, reduced.)



Psaronius textilis. From a Specimen from New York
(Longitudinal Section.)

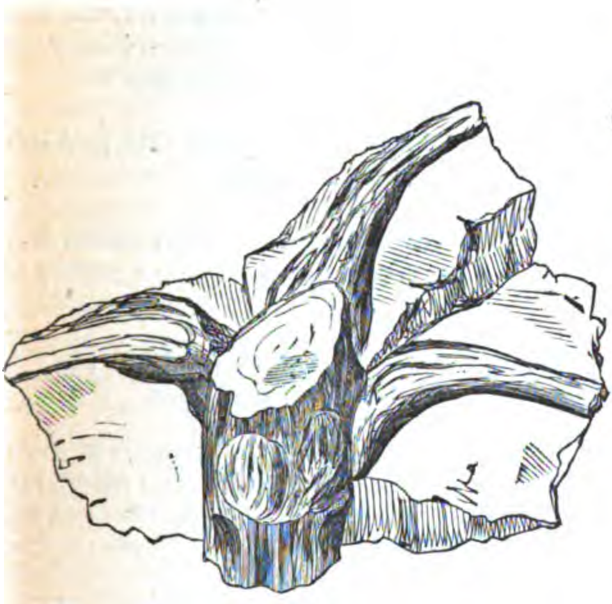
The minute structures are not well preserved. The specimens are from Madison Co., N. Y.—Hamilton Group; in Prof. Hall's collections.

104. *Psaronius textilis*, S. N.—U. D., New York.

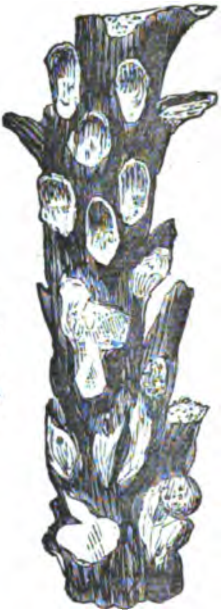
Trunk, with the outer surface marked with irregular ridges and furrows, produced by tortuous aerial roots, which in the centre of the stem are seen to be interlaced with each other. They are less tortuous in what seems to be the upper part of the fragment.

This specimen is in Prof. Hall's collection, and is from Gilboa, New York, where these trunks are stated to occur in an erect position in sandstone.

I may add to the above that Dr. Newberry has communicated to me two well-characterized trunks of tree ferns from the Devonian of Ohio, and another from Gilboa New York, so that the occurrence of large tree ferns in the Erian Flora is now well established. They are :—



Caulopteris Lockwoodi, (reduced.)
From a Specimen from Gilboa, New York.



Caulopteris antiqua, (reduced.) Ohio.

105. Caulopteris Lockwoodi, Dn.—U. D., New York.

106. Caulopteris antiqua, Newberry.—L. D., Ohio.

107. Protopteris peregrina, Newberry.—L. D., Ohio.

I have described these three species in a paper contributed to the Geological Society of London, March 22, 1871. They have not been found in Canada; but are of interest as shewing the existence of tree ferns in strata even older than the fern beds of St. John. In Gaspé I have found some fossil stems which are probably tree ferns, but too obscure for description. Illustrations of two of these trunks of tree ferns are given in the wood-cuts.

(*Fruits, &c*).

GENUS—CARDIOCARPUM—BRONG.

108. CARDIOCARPUM CORNUTUM, Dn.—(Pl. XIX., Figs 214 to 218.) —J. G. S., XVIII 324; Pl. XIII., Figs 23 and 24.—M.D., St. John, New Brunswick.

" Broadly ovate, emarginate at base, dividing into two inflexed processes at top. A mesial line proceeds from the sinus between the cusps, downward. Nucleus more obtuse than the envelope, and acuminate at the top. Surface of the flattened envelope striate, that of the nucleus more or less rugose. Length about seven lines."

109. CARDIOCARPUM BAILEYI, Dn.—(Pl. XIX., Fig. 219.)—Acad. Geol., p. 554.—M. D., St. John, New Brunswick.

Broadly cordate; emarginate at apex, one inch and a half broad, one inch long. Nucleus large, broadly oval, acuminate, with a mesial line reaching to the ends.

110. CARDIOCARPUM CRAMPII, Hartt.—(Pl. XIX., Figs. 220 to 222.)—Acad. Geol., p. 554.—M.D., St. John, New Brunswick.

Elongate, slightly expanding at the middle, obtuse at base. Obtuse or emarginate at apex. Length about one inch, greatest breadth about two fifths of an inch; nucleus small, central, oval, connected by a mesial line with the extremities. Surface of margin slightly rugose."

111. CARDIOCARPUM OVALE, S. N.—(Pl. XX, Figs. 223, 224.)—M.D., St. John, New Brunswick.

Oval and destitute of a notch, the sides of the margin expanded laterally, the nucleus ovate and acuminate.

This species, found with those above-named, but more rarely, seems to have been of similar structure.

112. Cardiocarpum obliquum, Dn.—(Pl. XIX, Figs. 225, 226.)—J. G. S., XVIII, 324; Pl. XIII, Fig. 25.—M. D., St. John, New Brunswick.

"Unequally cordate, acuminate, smooth, with a strong rib passing down the middle; length about three lines."

This species may have been of different character from the preceding, or may have been a nucleus deprived of its investments.

All of the above species of fruits agree in having a dense coaly nucleus of appreciable thickness, even in the flattened specimens, and surrounded by a thin and veinless wing or margin. They have thus precisely the appearance of samaras of many existing forest trees, some of which they also resemble in the outline of the margin, except that the wings of samaras are usually veiny. They are in like manner very similar to the *Cardiocarpa* of the coal-formation. The character of the nucleus and the occasional appearance in it of marks possibly representing cotyledons or embryos, forbids the supposition that they are spore-cases. They must have been fruits of Phaenogams. Whether they were winged fruits or seeds, or fruits with a pulpy envelope like those of Cycads and some Conifers, may be considered less certain. The not infrequent distortion of the margin is an argument in favour of the latter view, though this may also be supposed to have occurred in samaras partially decayed. On the other hand, their being always apparently flattened in one plane, and the nucleus being seldom, if ever, found denuded of its margin, are arguments in favour of their having been winged nutlets or seeds. Until recently I had regarded the latter view as more probable, and so stated the matter in the second edition of Acadian Geology. Last winter, however, when examining the collection of Dr. Newberry, in New York, that accomplished palæontologist pointed out to me the close resemblance between some fruits of this kind from the Carboniferous of Ohio and the drupaceous fruits of a recent Cycad. Re-examining the numerous specimens in Prof. Hartt's collection with this additional light, I have arrived at the conclusion that the *Cardiocarpa* of the type of *C. cornutum* were Gymnospermous seeds, having two cotyledons imbedded in an albumen and covered with a strong membranous or woody tegmen surrounded by a fleshy outer coat, and that the notch at the apex represents the foramen or micropyle of the ovule. The structure was indeed very similar to that of the seeds of *Taxus* and of *Salisburya*. In Plate XIX, Figs. 216 and 217 show very well the nucleus with its cotyledons and investing tegmen, while Fig. 218 shows the outer coat or fleshy testa, and exhibits the true character of the terminal notch or foramen.*

GENUS TRIGONOCARPUM—BRONG.

113. TRIGONOCARPUM RACEMOSUM, Dawson—(Pl. XIX, Fig. 227.)—J. G. S., XVIII, 324; Pl. XVI, Fig. 47.—M. D., St. John, New Brunswick.

"Ovate, obtusely acuminate, in some specimens triangular at apex. In flattened specimens the envelope appears as a wing. Fruits attached in an alternate manner to a thick, flexuous, furrowed rachis."

114. TRIGONOCARPUM PERANTIQUUM, S. N.—(Pl. XIX, Fig. 228.)

Ovate; when full grown, half an inch wide and one inch long, with obscure indications of ribs toward the narrow end.

St. John, New Brunswick, in Prof. Hartt's collections. All are badly preserved. They resemble some of the Carboniferous *Trigonocarpa.*

All Trigonocarpa, properly so called, are, I have no doubt from their associations, fruits of Sigillariæ or of Conifers; and the first species mentioned above shows that in some cases at least they were borne in racemes. a circumstance which should perhaps connect them with some of the spikes of fructification of the genus *Antholithes.*

GENUS CARPOLITHES.—STERNB.

115. CARPOLITHES SILIQUA, Dawson.—J. G. S., XIX, 465; Pl. XVII, Fig. 4.—U. D., Perry, Maine.

"Elongate, smooth, flattened, sides slightly sinuate; two inches or less in length; a quarter of an inch or less in breadth."

116. CARPOLITHES SPICATUS, Dawson.—J. G. S., XIX, 461; Pl. XVII, Fig. 15.—U. D., Perry, Maine.

"Carpels or spore-cases: oval, about a line in length, apparently with a thick outer coat; densely placed on a thick rachis."

This I now think may be the fruit of a species of Arthrostigma.

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* Though I have no doubt that the above is the correct interpretation of *C. cornutum*, I do not regard it as applicable to all Cardiocarpa, in some of which the outer envelope, instead of being succulent, may have been compressed into a wing. This was probably the case with *C. Baileyi*, which as Mr. Carruthers and Dr. Hooker have pointed out to me, is not dissimilar from the winged seeds of the curious *Welwitschia mirabilis.*

117. CARPOLITHES LUNATUS, Dawson.—J. G. S., XIX, 464; Pl. XVII, Fig. 11.—U. D., Perry, Maine.

"Base rounded regularly, apex broadly truncate and mucronate; nucleus surrounded with a narrow margin."

118. CARPOLITHES COMPACTUS, S. N.—(Pl. XIX, Fig. 229.)

Groups of small, oval bodies, about one-eighth of an inch in diameter, lying in masses as if they had been attached to a thick and short stalk.

This is evidently a mass of fructification, but of unknown nature. It is from St. John.

GENUS ANTHOLITHES.—BRONG.

119. ANTHOLITHES DEVONICUS, Dawson.—(Pl. XIX, Fig. 235.)—Acad. Geology, p. 566, Fig. 194.—M. D., St. John, New Brunswick.

"Stipe thick, rugose; flowers distichous, somewhat distant, each with straight strong spine or bract and several broader scales."

I figure a very fine and perfect specimen of this species, and have attempted a partial restoration of it in fig. 238, b. c. In this species the floral leaves are so well marked, and the indications of internal filaments representing stamens or pistils are so distinct, that I cannot doubt that it is a spike of fructification of some phaenogamous plant.

120. ANTHOLITHES FLORIDUS, S. N.—(Pl. XIX, Fig. 236.)

Flowers or buds composed of six to nine sub-equal oblong obtuse bracts or floral leaves; arranged in an opposite manner on a thick rugose axis.

This species at first sight recalls the curious Permian *Schützia anomala* of Geinitz; but it wants the scaly bracts of that species. Like the former this must, I suppose, have been the fructification of some phænogamous, possibly gymnospermous plant.

GENUS SPORANGITES.—DN.

121. SPORANGITES ACUMINATA, Dn.—(Pl. XIX, Figs 232 to 234.)

"*Spore-cases: oblong acuminate, six to nine in a whorl; erect, or slightly spreading. Dehiscence lateral.*"

I place under this name the objects described in former papers as *Annularia acuminata*. Additional specimens lead me to believe that these supposed whorls of leaves are really clusters of spore-cases which may have belonged to *Psilophyton* or to ferns. They are not very dissimilar from the spore-cases of *Psilophyton robustius*.

122. SPORANGITES HURONENSIS. Dn.—Silliman's Journal, April, 1871. Canadian Naturalist, Vol. V, new series. Under this name I have described the small globular papillate spore-cases found so abundantly at Kettle Point, Lake Huron, in beds believed to be of Hamilton age. They are probably spore-cases of some Lepidodendroid plant, and are so abundant as to give a highly bituminous character to the shale.

VARIOUS FRUITS, &C.

In Figures 230 to 232, I have represented several obscure seeds and similar organs from St. John, and in Figs. 124 to 126, Pl. X, some similar objects from Gaspé. That in fig. 126 is probably a concretion enclosing some organic body, the others may perhaps be badly preserved fragments belonging to some of the species above described.

It will be observed that the above mentioned fruits and floral organs constitute a series strictly parallel to the more common fruits of the Carboniferous; so that whatever genera these last belonged to, must have been represented also in the Devonian. Unfortunately our knowledge of the affinities of Carboniferous fruits is too imperfect to give us much information on those of the older series. Such inferences as I have been able to draw I have already stated above.

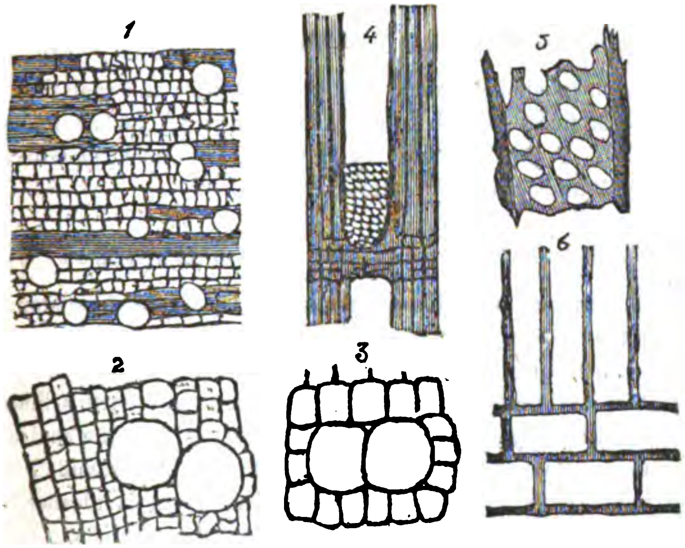
(*Angiospermous Exogen.*)

GENUS SYRINGOXYLON.—DN.

123. *Syringoxylon mirabile*, Dn.—Journal of Geological Society, XVIII, 305; Pl. XII, Fig. 145.—M.D., New York.

I have nothing to add to the description of the species cited above: but after careful re-examination of the slices prepared, find my views of its structure and affinities, therein stated, fully confirmed. I give improved drawings of some of these structures in a supplementary cut, shewing the nature of its dotted ducts and woody fibres, in hopes that they may be recognised in this country.

As the only plant of this grade as yet known in the Palæozoic rocks, it is of the greatest interest; and I have sought earnestly for further examples, carefully examining all fragments of Devonian wood which I have been able to obtain. As yet, however, no other specimen has been obtained than that from the Hamilton Group (Middle Devonian), at Eighteen Mile Creek on Lake Erie, originally submitted to me by Prof. Hall.



Syringoxylon Mirabile.

Fig. 1. Transverse section, 100 diameters, showing vessels, woods-cells and medullary rays.
Fig. 2 and 3. Portions of the same, 300 diameters.
Fig. 4. Longitudinal section of dotted duct, wood-cells and medullary rays, 300 diameters.
Fig. 5. Wall of dotted duct, 600 diameters.
Fig. 6. Wood-cells and medullary rays, 600 diameters.

Uncertain Species.

Megaphyton, sp.—J. G. S., XVIII.
Acanthophyton spinosum, Dn.—J. G. S., XVIII.
Cyclopteris incerta, Dn.—Ibid.
Fern with netted veins, Dn.—J. G. S., XIX.
Cyclopteris, sp., Dn.—Ibid.
Selaginites formosus, Dn.—Can. Nat., VI; J. G. S., XVIII, 316.

The first five of the above are forms still too uncertain to be classified. The last I desire to abandon as a vegetable species. It was founded on specimens obtained at Gaspé, which seemed to me to represent scaly stems or branches. The late Mr. Salter suggested that they might be fragments of some Eurypteroid crustacean. At the time I thought that the shape of the specimens precluded this supposition, but a number of additional fragments since obtained, have convinced me that Mr. Salter was right, and consequently, that a great quantity of fragments of a large species of *Eurypterus* have been entombed in one of the shales associated with the coal-bed near Tar Point.

(*Endogen ?*)

125. *Noeggerathia Gilboensis*, Dn.—Proc. Geol. Socy., 1871.

This is a rhombic-obovate leaf with a broad base and radiating nerves or plicæ, with finer striæ between them. It is 3$\frac{3}{10}$ inches long and 2½ inches broad. It was collected by Rev. Mr. Lockwood, in Gilboa, New York. Its affinities are very uncertain.

(2.) *Vegetable Fossils of the Upper Silurian Limestones of Gaspé.*

These limestones immediately underlie the Gaspé Sandstones, and constitute the Peninsula of Cape Gaspé, in which they are admirably exposed. According to the measurements of Sir W. E. Logan they are 2000 feet in thickness. They consist of pure and earthy limestones, alternating with shaly bands, and rest unconformably on the shales of the Quebec Group (Lower Silurian). Their fossils, as examined by Mr. Billings, indicate that they are of the age of the Lower Helderberg Group of New York, equivalent to the Ludlow of English geologists.

The Gaspé Limestones are, throughout their whole thickness, essentially marine; and many of the beds, especially in the upper part, are loaded with animal fossils, principally corals and shells of Brachiopoda. Here and there remains of plants occur, but so rarely that they would perhaps have been scarcely noticed but for the excellent exposure of the rocks. They are principally fucoids, and these chiefly of two kinds. (1.) The remarkable spiral fronds of the genus *Spirophyton*, Hall, the Fucoides Cauda-galli of the earlier New York reports. These occur principally in some of the lower beds, though they extend upward into the bottom beds of the Devonian Sandstones. (2.) Tortuous linear fronds or stems, probably originally cylindrical, sometimes smooth, and in other cases presenting a scaly appearance, which, however, seems to be due to the arrangement of laminæ of fine sediment filling the interior of the moulds left by the stems. These scaly markings are sometimes so regular as to give the appearance of the Liassic fucoids to which Brongniart has given the name *Phymatoderma*, and which Schimper compares to species of *Caulerpa*. I believe, however, that the plants now under consideration were either long stems of frondose Algæ allied to *Spirophyton*, or cylindrical plants allied to *Chorda*.

Other fragments show the remains of a distinct internal woody axis, and must have been portions of acrogenous plants comparable with *Psilophyton* *glabrum* of the Devonian beds; but they are too imperfect to show their generic affinities. (Fig. 239). Others are branching stems, the form and markings of which show that they belong to *Psilophyton*, and probably to the species *P. robustius*, (Fig. 243). Others are obviously Rhizomata of *Psilophyton*, showing the ramenta and areoles; and one specimen collected by Mr. R. Bell, when exploring these rocks in connection with the Geological Survey, shows the scalariform axis, and outer fibrous bark in excellent preservation, thus fully proving its true nature, and vindicating the less perfect specimens from the doubts which in the minds of many botanists might otherwise rest upon them. This specimen is represented in Pl. XX, Figs. 241, 242; and I have shown its structure in Pl. XI, Figs. 133 and 134.

These remains of *Psilophyton* occur in the lower part of the limestone, but are more abundant in the upper beds, and they suffice to indicate the existence of neighbouring land, probably composed of the Lower Silurian rocks, and supporting vegetation. That this vegetation consisted wholly of plants of the genus *Psilophyton* we are under no necessity to believe, as the almost exclusive prevalence of these plants in some parts of the overlying sandstones, deposited at a time when we know that other plants existed, shows that in the Devonian period itself, this particular genus was either much more abundant than other forms of plants, or much more favourably situated for preservation.

It is interesting to observe that just as a few remains of plants in the marine limestones testify to the occurrence of neighbouring land, so an occasional shell of *Orthoceras* or a few Brachiopods may sometimes be found in the plant-bearing Devonian sandstones, showing that these were accessible to the driftage of oceanic remains; but we have no right in either case to assume that these exceptional remains represent the wealth of either the land or the sea in organic forms.

III. General Remarks and Conclusions.

(1.) *Physical Condition of Eastern America in the Devonian Period.*

As Hall and Dana have pointed out,* North America presented, in the earlier part of the Upper Silurian period, a great internal ocean, partially separated from the basin of the Atlantic by a more or less continuous belt of sand-banks or islands, representing the older portions of the Appalachian range of hills, and bounded on the north by Laurentian and in part by Lower Silurian land. These conditions prevailed during the deposition of the great Niagara limestones (Wenlock); and in the immediately succeeding or Salina epoch, there seems to have been a uniform elevation, leading to the prevalence over the same area, of shallow waters, liable in part to actual desiccation. Toward the close of the period, as in the like portion of each of the great cycles of American Palæozoic history, subsidence again occurred, and the marine limestones of the Lower Helderberg (Ludlow) formation overspread a still wider area in the eastern part of the continent than did those of the Niagara. Hence we find the marine beds of the Lower Helderberg rising high on the slopes of the Appalachians, while such patches as that of St. Helen's Island near Montreal * show that they at one time covered the Lower Silurian plain of Canada. The subsidence which enabled them to do this, was apparently accompanied by the ejection of the trappean masses which penetrate the Lower Silurian beds, and among the fragmentary débris of whose bases the remaining portions of Lower Helderberg limestone have in some places, as near Montreal, been entangled and preserved. In like manner, in Gaspé, in Anticosti, in New Brunswick, in Nova Scotia and in Maine, we have the extension of the same Lower Helderberg sea, proved by its fossiliferous deposits. And though, as I have elsewhere observed,† the fossils of the Nova Scotia rocks of this age, (Arisaig group) show a tendency to European rather than to American types, this merely indicates the partial interruption of the continuity of the great oceanic area, by the remaining shoals of the Appalachian ridge. It would thus appear that at the close of the Upper Silurian, the area of land in Eastern North America was at a minimum; being probably less than at any preceding period since the deposition of the great Trenton limestones of the Lower Silurian.

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* Report on Pal. of N. York, Vol. III.—Manual of Geology.

At the beginning of the Devonian a slow and gradual emergence, not accompanied by any fractures or physical disturbances, appears to have commenced. The wide spread of the Oriskany sandstone, and its accompanying arenaceous beds, indicates this change. This re-elevation was earlier and more permanent near the Atlantic coast than farther inland. West of the Appalachians, the Corniferous limestone, probably the finest coral limestone in the American Palæozoic series, indicates a wide internal ocean; while in Gaspé, New Brunswick and Maine, its place is occupied by beds filled with land-plants, and some of them even underclays or fossil soils, like those of the Coal-formation. Similar conditions followed somewhat later in the West; and the Corniferous limestone was covered with the shales and sands of the Hamilton and Chemung series, during the deposition of which the condition of all North America must have approached to that which it afterwards assumed in the time of the

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* Report of Geology of Canada, 1863.

† Acadian Geology.—See also paper by Dr. Honeyman, in Journal of Geol. Society.

Coal-formation, though presenting some characteristic differences, more especially in the less extensive prevalence of swampy flats. Contemporaneously with the very beginning of these physical changes appeared the Erian Flora. Already, before the close of the Upper Silurian, the first patches of emerging land must have become clothed with *Psilophyton*, and by the time of the Middle Devonian the flora of the period had, at least on the Atlantic coast, attained to its culminating point.

At the time when the Erian or Devonian Flora attained to its greatest extension, there must have been in Canada a considerable extent of Laurentian and Lower Silurian land. The Adirondack hills were out of the water, and so were the older portions of the Appalachians, and from these there stretched to the East, West and South, considerable tracts of low land; portions of which were alternately dry and submerged according to the varying level of the continent. Upon these flats, and in part also, probably, on the neighbouring hills, flourished the plants which have been described in the preceding pages, and which appear to have enjoyed climatal and atmospherical conditions similar to those of the Carboniferous period, but with a smaller continental area and greater proportionate irregularity of surface.

At the close of the Devonian, in the regions lying east of the Appalachians, great physical disturbances occurred. The lowest Carboniferous rocks are generally coarse and conglomerated, often interstratified with contemporaneous trap, and rest unconformably on the Devonian. The latter rocks are much altered, and this metamorphosis is connected with the intrusion of great masses and dykes of granite which penetrate the Devonian, and were consolidated before the deposition of the lowest Carboniferous beds. These disturbances were the prelude to the great change in animal and vegetable life which we find in the lowest Carboniferous beds, and to the subsidence evidenced by the prevalence of the Lower Carboniferous limestones, which separate as by a great gulf the Lower Carboniferous flora from that of the Middle Coal formation.

In the east these changes were already in progress in the latter part of the Devonian, as evidenced by the coarse sandstones and conglomerates of the old red sandstone. In the west they did not occur, or were postponed till after the Carboniferous had begun, since in Ohio we find a gradual passage from the Devonian into the Carboniferous, while a partial unconformability occurs between the Lower Carboniferous and the Coal-formation. Even in the west, however, the Devonian Flora disappears at the beginning of the Carboniferous period.

The above general sketch may serve to present a view of this remarkable period in Eastern America. It might be illustrated in detail by a great number of local examples. These will be found in the Surveys of New York, Pennsylvania and other States of the American Union, in the Report of the Survey of Canada, and in the author's "Acadian Geology." In Europe such a general view is attended with greater difficulty, owing to the less breadth of the formations and the greater prevalence of local diversities, and also to the want of definition in some localities between the Upper Devonian and the Lower Carboniferous. Still the same division into Lower, Middle and Upper Devonian exists, and the same general relation both in fossils and physical conditions, to the Upper Silurian on the one hand, and the Carboniferous on the other.

(2.) *Comparison with the Carboniferous Flora.*

Generically the Flora of the Erian or Devonian is in the main identical with that of the Carboniferous, and the most important and characteristic Carboniferous genera are also among those best represented in the older Flora. On the other hand, while some Carboniferous genera have not yet been recognized in the Devonian, the latter possesses some peculiar generic forms of its own, and these are especially abundant in the lower part of the system. As examples of such genera I may name *Psilophyton*, *Prototaxites*, *Leptophleum* and *Arthrostigma*. Further, it may be remarked that these peculiar Erian plants present highly composite or synthetic types of structure, giving to them a more archaic air than that of the Carboniferous flora.

Perhaps the most remarkable of all the generic differences of the Carboniferous and Erian flora is the occurrence in the latter of the exogenous genus Syringoxylon, a type altogether unknown otherwise in the Palæozoic. In one point of view this may indicate the greater variety and perfection of the older of the two floras. In another it may merely warn us as to the imperfection of our knowledge. With regard to the proportionate prevalence of particular genera, we are as yet scarcely in a position to make any definite statement. Not only is our information very incomplete, but there is a remarkable variety in the Devonian itself, in different localities. In Gaspé, for example, *Prototaxites* and *Psilophyton* are predominant forms. In New Brunswick, New York, and Ohio, these forms are less abundant. In New Brunswick fronds of ferns are present in great numbers, while they have scarcely been found in Gaspé; and trunks of tree ferns and petioles without leaves have been found abundantly in Ohio and New York, where fronds of these plants are comparatively rare. We can scarcely at present decide whether these differences result from different facilities for preservation,* or from local diversities of soil and climate, or from different dates of the plant-bearing beds. On the whole, however, as I have elsewhere remarked, while the distribution of genera in the Devonian leads us to infer climatal conditions in the main resembling those of the Carboniferous, it would also lead us to conclude that the local diversities were greater, and that there was less of that dead level of similar local conditions which prevailed so extensively in the Carboniferous period. The Devonian plants probably grew on limited rocky islands, bordered by much less extensive and permanent lowlands than those of the Carboniferous era.

Specifically the Devonian flora is almost altogether distinct from the Carboniferous. Even the same genera are represented by distinct species, and it is possible that some of the few species which we now identify with those of the Coal, will in future be found to be distinct. I presume, at least, that this is more likely than that those esteemed distinct shall be found to be identical.

The specific differences also point in certain definite directions. The coniferous trees are of more lax texture, and with larger woody fibre in the Pre-Carboniferous beds. The Sigillariæ and Lepidodendra are smaller and more delicate. The ferns present a tendency to the extremes of small and delicate, and very large and expanded fronds. They have generally a tendency to a flabellate venation decurrent on the petiole. There is a remarkable abundance and variety of Lycopodiaceous plants. We shall find that it is probable that in the course of the Devonian period itself, great changes occurred in some of these points.

Of all the known localities of Erian plants in Eastern America, that of Gaspé presents an assemblage the most primitive and the least Carboniferous in aspect. That of Southern New Brunswick gives us a flora the most akin to that of the Carboniferous. The lower part of the Gaspé series undoubtedly reaches to the base of the Devonian; this is proved by its marine fossils, but its middle and upper parts must be at least on as high a horizon as that of the New Brunswick beds. More especially does this appear when we consider that, as I have shown in a previous paper, and as Prof. Bailey and Mr. Matthew have since fully confirmed, the latter have been altered and disturbed before the deposition of the Lowest Carboniferous beds, and that they appear to underlie the Devonian beds of Perry in Maine. These facts show that they should be regarded not as Upper Devonian, as I was at first inclined to believe, but as belonging to the middle of the series.

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* In the Middle Devonian we may conceive the plant beds of New Brunswick to represent an estuary or swampy lagoon, while those of New York and Ohio are open sea areas, into which leaves long macerated in water were drifted.

In the lower part of the Gaspé series representing the Lower Devonian, the extreme abundance of *Psilophyton* and *Arthrostigma*, and the occurrence of *Prototaxites* as the only representatives of the Conifers, give an aspect of great antiquity to the flora. In the middle part of the same series we find these forms associated with *Lepidodendron* and *Stigmaria* and *Lepidofloios;* and at a corresponding horizon in New York and New Brunswick we find Ferns, *Cordaites* and other types not occurring, as far as known, in the lower beds. I shall present in the sequel some reasons for the belief that the middle of the Devonian is the true meeting-place of the last survivors of an old Silurian flora and the earlier representatives of the flora of the later half of the Palæozoic. In the meantime I may refer for a moment to views of the sequence of Palæozoic plants which might be entertained in accordance with theories of derivation of species now prevalent. The Lower Devonian is distinguished by the abundance of some remarkable forms referred to Algæ of the genera *Spirophyton* and *Dictyophyton* of Hall, also for the occurrence of vast quantities of humbly organized acrogens suited for a semi-aquatic habitat, as *Psilophyton* and *Annularia.* May not these two groups of plants be related in the way of derivation? Again, the synthetic types of acrogens of the Lower Devonian, and the prototypal exogens of the genus *Prototaxites* give way in the Middle Devonian to more perfect and specialized types of acrogens and gymnosperns; may they not have been advanced by a process of evolution? Such speculations have many charms for persons of vivid imagination, and may be supported by the analogy between the progress of the development of the individual plant and the succession of plants in geological time; but the present case affords to them a support more apparent than real. The gap between Algæ and acrogens like *Psilophyton* with a well developed scalariform axis, is very great. The Algæ in question did not precede *Psilophyton* but were contemporaneous with it, and their association may be explained by the co-existence of submerged shallows favourable to Algæ, and swampy flats favourable to *Psilophyton* and its allies, and by the alternation of these conditions in the same locality. *Prototaxites* does not change into *Dadoxylon.* It disappears and is replaced by a type of wood which continues to the present day. *Psilophyton* continues to exist without improvement along with the *Lepidodendra* and ferns of the Middle and Upper Devonian, and merely becomes less abundant until it finally disappears. The phenomena are rather those of the gradual extinction of an old flora and the introduction of a new one from some different source. If therefore we desire to account for the succession of floras in this way, we must suppose local extinction and the introduction from another region of plants which in the meantime have been modified there. It thus becomes a necessary preliminary to investigate the local distribution of each flora, its probable place of origin and direction of distribution, the regions into which it might retire when displaced locally by subsidences, and the manner of its extension after re-elevation. Such questions require much careful observation and comparison of facts, and it would be more profitable to attend to them with vigour than to waste time in discussing premature hypotheses. North America affords probably the finest field in the world for their solution, and the discussion of the facts relating to them by Prof. Hall in the Introduction to his Palœontology of New York, Vol. III., is as yet the most important contribution to this.

Another point deserving of notice is the scarcity of coal in the Devonian series. I am inclined to attribute this rather to geographical and climatal conditions than to any incapacity in the *Sigillariæ* and *Calamites* and *Lepidodendra* of the Devonian to produce accumulations of coal. The genus *Psilophyton* also seems to have been well suited to form such accumulations; and indeed the little coal-seam at Gaspé Bay is chiefly composed of the remains of this plant. It would, however, be remarkable if conditions favourable to the accumulation of large deposits of coal did not occur in some portion of the areas of Devonian deposition; and I should not be surprised if at any time such deposits should be found to occur locally in some part of Eastern America.

In conclusion of this topic, the plants figured in this Report will enable any good observer to recognise the flora of the Devonian, and to distinguish it from that of the great coal series, and thus to avoid the mistake of supposing the plant-bearing beds of the older series to indicate the presence of productive coal measures, a mistake which has led to some costly and useless mining operations.

(3.) *Comparisons with the Equivalent Flora of Europe.*

The Devonian of Europe is so imperfectly developed in comparison with that of America, that whether we compare the fauna or the flora, we must bear in mind that while the lapse of time represented in both continents may be the same, the extent of rock formations deposited and the amount of life manifested in the fossil remains, vastly preponderate in America. This preponderance is greater than the published lists of fossils would indicate, since the rocks of this period in America relatively to their area and thickness, have been less perfectly explored. In Western Europe also local disturbances and differences of deposit, and the passage in some places of the Upper Devonian into the Carboniferous, have caused doubts as to the classification of the beds, which have comparatively little place with reference to these formations in America. For such reasons geologists and palæontologists whose vision is limited by the European rock formations, can scarcely avoid a feeling of scepticism as to the results obtained in the study of these rocks in America; and it is with the view of keeping this distinctly before their minds, and of asserting the actual fact that America is the typical region of these deposits, that I have suggested the term *Erian* for this formation in the present memoir.

Our knowledge of the flora of the Devonian, more especially in Europe, is as yet too imperfect to admit of the certain comparison of the vegetation of different areas. I shall therefore content myself with a comparison of known facts, without venturing on general conclusions. I have shown in my Acadian Geology that the Carboniferous Flora of Nova Scotia and New Brunswick is very closely allied to that of Europe. Out of 196 nominal species catalogued in that work we may reject forty-four as uncertain, or as founded on fragments which may belong to species bearing other names. Of the 152 actual species remaining, ninety-two are common to Nova Scotia and to Europe, in so far as I have been able to make comparisons. In general terms it may be stated that of the coal plants of Nova Scotia and New Brunswick, two-thirds occur on the eastern side of the Atlantic as well. Crossing the Appalachian ridge we find that only fifty-nine species, or rather more than one-third, are common to Nova Scotia and the interior coal areas of the United States. Farther, according to Dana's summary of the results of Newberry and Lesquereux up to 1860, out of 350 species of the United States Coal fields, 146 only are found in Europe. Making every allowance for imperfect information and errors in comparing species, these facts indicate that in the Carboniferous period the Appalachians constituted a more important physical barrier than the Atlantic, and that the Flora of the Atlantic slope of America was much more closely allied to that of Europe than that of the great internal plain of the American Continent.

In the Devonian period, while a few species, like *Psilophyton princeps* and *Lepidodendron Gaspianum* are of continental distribution, the plants of different localities, as for instance, those of Gaspé and New Brunswick, and those of the latter and New York, are in the main distinct, though belonging to the same generic forms; and almost the same statement may be made with reference to the comparison of any of these American areas with those of Europe. This, no doubt, implies imperfect information; but if any general conclusion can be deduced from it, this must be that already referred to, and stated in a former paper on this Flora,* that in the Devonian period there was a less uniform and monotonous flora in the northern hemisphere than that which existed in the succeeding Carboniferous period.

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* Journal of Geol. Society, Vol. XIX.

As an illustration of the difficulty of comparison, I may refer to the remarkable fact that the genus *Psilophyton,* so characteristic of the American flora in this period, had not, until noticed by me in 1870, been recognised in the Devonian of Europe. That this depends altogether on defective preservation of specimens, or defective observation, I am fully convinced. There can be little doubt that the species *Halisites Dechenianus* Goept., so abundant in the rocks of this age in Germany, is founded on badly preserved specimens of *Psilophyton.* So are the "branching roots," "grass-like plants," and "curved fucoids," which have been described as occurring in the Old Red Sandstone of Scotland.* Unger has also described the internal structure of certain stems from the Devonian of Thuringia, which, if preserved in respect to their external markings, would very probably be found to be stems of Psilophyton.† These probabilities were fully discussed in my Paper on the Devonian plants of Gaspé in the Journal of the Geological Society, vol. xv, page 482. Yet though ten years had elapsed since the publication of that paper, it would seem that no specimens comparable with those found so abundantly in Gaspé had been discovered in Europe.

As an example of the same kind, but in favour of the European flora, I may mention that the genus *Cyclostigma,* recognized many years ago in Ireland by Haughton, has been found in America for the first time in 1869.

On the other hand the fact of greater diversity, at least of station, in the Devonian period, seems to be proved by the character of the flora itself, as well as by the great differences between the proportions of different genera and species in localities not very distant from each other, above referred to. It is perhaps equally illustrated by the striking similarity in the flora of places somewhat remote from each other, as Perry in Maine, and Montrose in Pennsylvania.

It is, however, important, in the interest of Palæobotany, to observe that the facies of the Erian flora is very similar on both sides of the Atlantic, so that a botanist familiar with the differences between the plants of the Carboniferous and Devonian in America or in Europe, would have no difficulty in applying this knowledge to the separation of the rocks of these periods in any part of either continent.

When in London in the spring of 1870, I was enabled, through the kindness of Mr. Etheridge and Mr. Carruthers, to examine the specimens of Upper Silurian and Devonian plants from Great Britain and Ireland, in the collections of Jermyn Street and in the British Museum. These collections illustrate the descriptions of Dr. Hooker, Mr. Salter and Mr. Bailey, and contain besides some unpublished material. They enable me to add the following comparisons.

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* Salter on Plants of Caithness. Journal of Geol. Society, Vol. XIV.

† E. G. *Clepsidropsis antiqua.*

In specimens from the Upper Silurian (Ludlow beds), in addition to the remarkable bodies described by Hooker under the name *Pachytheca*, and which are probably spore-cases, there are fragments of flattened stems which may be referred with some probability to *Psilophyton*, and small pieces of carbonized wood, showing under the microscope a distinctly fibrous structure with indications of discs. They may well have belonged to a plant of the nature of *Prototaxites*.*

In specimens from the Middle Devonian of Scotland, the remarkable stem described by Salter as *Caulopteris Peachii* indicates a sub-arborescent fern, with large fronds, of which the petioles alone remain. *Lepidodendron nothum*, identified by the same author, is a plant closely allied to *L. Gaspianum*. A species referred to *Selaginites*, may belong to the same general group with *Lycopodites Richardsoni*. There are also fragments referrible to *Psilophyton princeps* and *P. robustius*, and portions of carbonized stems, for the most part structureless, but one of which shows woody tissue with oval pores inscribed in hexagonal meshes, and which may have belonged to *Sigillaria* or *Calamodendron*.

From the Upper Devonian of Ireland, there are fine collections made by Mr. Bailey in the Kiltorcan beds. In these *Cyclopteris* (Archæopteris) *Hibernica* represents our American *C. Jacksoni* and its allies. There are two Sphenopterids, *Filicites lineatus* of Bailey, and *Humphrianus* of Schimper. There is also a remarkable series of specimens believed to illustrate the genus *Cyclostigma* of Haughton.† The smaller branches and stems are those described by Haughton. The larger stems have rounded margined areoles with a central scar, and spirally arranged, sometimes on faint narrow ribs like those of *Syringodendron* which the scars also resemble; and there are well developed Stigmaria roots and Lepidodendroid leaves and strobiles referred to the same plant. The largest stems are labeled *Sagenaria Baileyana*, but they certainly do not belong to the genus *Sagenaria* as heretofore defined. If the whole of the parts referred to this plant really belong to one species, it will constitute one of the most remarkable of the composite types of the Devonian, and may prove characteristic of it. My species *Cyclostigma densifolium* is of the same character with the branches of the present species. The Irish plants as a whole would seem to have been larger and better developed than those of North America in the Upper Devonian period, perhaps a consequence of climatal difference.

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* Slices of these plants have been prepared through the kindness of Mr. Etheridge, and I have no hesitation in stating my belief that they indicate the existence in the Upper Silurian of England, of trees of the type of *Prototaxites*.

† Proceedings Royal Irish Academy.

From the typical districts of Devonshire, I have seen only a few specimens, from the collection of Mr. Hall of Barnstaple, in the possession of Mr. Etheridge. They appear to indicate a large fern, perhaps *Cyclopteris Hibernica*, and a coarsely ribbed *Calamites* apparently of the type of *C. cannæformis*.

Coniferous wood was long ago recognized by Miller in the Devonian of Scotland; and from a recent description of the specimens by Mr. McNab of Cirencester,* they would seem to be referrible to the type of *Dadoxylon*.

While in Edinburgh I was favoured by Mr. C. W. Peach with an inspection of his interesting collection of plants from the Devonian of the North of Scotland, and have also looked over a few specimens of similar plants from the collections of the late Hugh Millar, exhibited in the Edinburgh Museum. In these collections, more especially in that of Mr. Peach, I find two species of *Psilophyton*,—one of them apparently *P. princeps*, the other allied to *P. robustius*, but probably distinct. None of the specimens show the fructification, but there are large and well-preserved rhizomata; and according to Mr. Peach these plants are as abundant, relatively to others, in the Middle Devonian of Scotland as in that of Gaspé, though they have hitherto been regarded as fucoids or roots. On many of the specimens I can plainly perceive all the distinctive markings of *Psilophyton*. There are apparently, in Mr. Peach's collections, three species of Lepidodendroid plants. One of these, identified with *L. nothum* by Mr. Salter, whether identical with the species of Unger or not, is closely allied to *L. Gaspianum*. Another, is obviously of the same type with my *Cyclostigma densifolium* from Gaspé, and with the branchlets of *Cyclostigma* from Kiltorcan in Ireland. The third, *Lycopodites Milleri* of Salter, may have been an herbaceous plant. Mr. Peach's collections also include a *Cyclopteris* of the type of *C. Brownii*, a Calamites resembling *C. transitionis*, a Stigmaria, fragments which may be bark of *Sigillaria*, a plant possibly referable to the genus *Anarthrocanna*, and stems or branches probably coniferous, though the structure does not appear to be well preserved. When these collections shall be described in detail, it will be found that the Devonian of Scotland is not so poor in land plants as has been supposed, and that its flora is very similar to that of America in the same period.

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* Philos. Maga.

(4) *Relations to Older Floras.*

As already stated in the opening of these remarks, the close of the Upper Silurian Period in Eastern America was a time of minimum extent of land. Hence, the Upper Silurian beds, immediately under the Devonian, are decidedly marine, and in entering them we not only pass to older rocks, but also recede from the land, so that for both these reasons we might expect to find a great diminution in the number of land plants. Further, in accordance with the views which have been so well illustrated by Prof. Hall as to the derivation of American Silurian sediment from the North-east, and the gradual extension in each succeeding period of land and shallow water to the South-west, we should expect to find the oldest land-plants toward the North-east.

Accordingly it is in Gaspé that as yet we have the only link of connection of the Erian Flora with that of the Silurian period. In the marine limestones of Cape Gaspé, holding shells and corals of Lower Helderberg age, along with some indeterminable plants, probably fucoids, we have, as already stated, fragmental stems and distinct rhizomes of *Psilophyton*, some of them showing the scalariform axis well preserved. These fragments must have been drifted from the land, and as in the immediately succeeding Lower Devonian beds, *Psilophyton* is associated with *Prototaxites*, *Arthrostigma*, and *Calamites*, but is the most abundant of the whole, it is not unlikely that in the Upper Silurian land it was associated with plants of these genera.

Nor is it necessary to suppose that the duration of the existence of the plants represented by these fragments was short. In the modern Pacific the area of land is very small, and few remains of land-plants are probably preserved in the marine deposits now in progress. But if that great basin were elevated, so that much low land would exist in it, and also wide spaces of shallow water with muddy bottoms charged with numerous land-plants, it would not be fair to assume that the comparatively sparse vegetable remains of the lower marine beds represented either a very meagre flora or one of short duration. The same reasoning would apply to the Lower Helderberg limestones as compared with the succeeding Gaspé Sandstones. More especially would this be the case if the plants in question belonged to an older flora migrating from the north-eastward, as the new lands laid bare at the beginning of the Devonian Period gradually rose above the waters.

In any case, these well characterised Upper Silurian land-plants, described by me in 1863,* distinctly prove that before the disappearance of the Upper Silurian marine fauna, or of the ocean in which it lived, there already existed land clothed with at least one genus of Lycopodiaceous plants, and this the same which largely predominates in the succeeding Lower Devonian, in which, however, these plants, occurring merely as drifted fragments in the Upper Silurian limestones, are found in vast numbers in a perfect state of preservation, and rooted in the soil in which they grew.

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* Journal of Geol. Society, XIX.

Below the Upper Silurian our knowledge of the land flora in Eastern America altogether fails. Notwithstanding the evidence of shallow-water conditions on the flanks of the Appalachians, in the conglomerates and sandstones of the base of the Upper Silurian, no land-plants have been found in these beds; and though in the Lower Silurian the Potsdam sandstone, skirting the base of the old Laurentian nucleus, must have been formed near the shore, and sometimes abounds in carbonized fragments, perhaps of fucoids, no certain traces of land-plants have been found in it. This is the more remarkable since in some portions of the Lower Silurian period a broad surface of land must have existed in the northern part of Canada. Could we discover the estuaries of any of the streams which flowed from this old land, some hope might be entertained of the discovery of terrestrial vegetation. If, however, with Prof. Hall, we regard the origin of the Silurian sediments and of the land flora to have been in the north-east, it is possible that the rocks of Newfoundland or Labrador, or beds now buried under the Atlantic, may be those which alone contain the remains of the Lower Silurian plants.

In Europe the precursors of the Devonian flora are better known than in America. The *Pachytheca* of Hooker from the Ludlow Bone-Bed, may be regarded as of similar age with the *Psilophyton* of the Gaspé limestone; and like it probably Lycopodiaceous. Of equally ancient date are the *Sagenaria* (*Lepidodendra*) discovered by Geinitz in the Upper Silurian of Lobenstein, and by Barrande in that of Hosten, Bohemia, and the *Hostinella* of Burr from the last mentioned locality.* The *Eophyton* of Torrell, from a much lower horizon in Sweden, I regard as a doubtful plant, similar forms being apparently produced by impressions of feet or fins on the surface of mud. If a land-plant, however, the *E. Linœanum* is more nearly allied to *Psilophyton* than to any other genus. Whatever the nature of these forms, they are present in the Primordial of America as well. Mr. Murray has found them in Newfoundland and Mr. Selwyn in Nova Scotia, in rocks probably of this age. The *E. explanatum* of Mr. Hicks from the Lower Arenig rocks of Wales is apparently something quite different, and its microscopic structure would seem to be similar to that of the *Nematoxylon* of the Devonian, if it is a plant at all, and not a marine organism allied to *Pyritonema* of McCoy, a fossil similar to which Dr. Nicholson has found in the Llandeilo of Hart Fell, near Moffat.

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* Bigsby's Thesaurus Siluricus, p. 194.

Is it possible from so few facts to form any idea of the probable land-flora of the great Silurian age, and of its relation to that of the Devonian? I think it possible at least to arrive at some general notions on the subject, which may be reduced to the following statements:

1. It may be noted that no plants other than Lycopodiaceæ or allied forms have been detected below the Lower Devonian. That this may really indicate a greater antiquity of this family than any other is rendered more probable by the fact that Lycopodiaceæ increase in relative importance in descending from the Coal-formation to the Lower Carboniferous, and thence into the Devonian and Upper Silurian, where they appear to be left alone. Allowing for any possible amount of imperfection in the record, this can scarcely be an accident. If, however, *Eophyton explanatum* should prove to be a land-plant allied to *Nematoxylon*, it may be possible that prototypal Gymnosperms or Endogens may have extended quite as far back in Geological time.

2. Should it prove certain that Acrogenous plants allied to Lycopodiaceæ, and perhaps such prototypes of Gymnosperms as *Eophyton*, extended back to the Primordial period, then we might look for the actual origin of land vegetation in the Laurentian. In a paper recently read before the Geological Society,* I directed attention to the fact that in the Laurention of Canada vast quantities of carbon exist in the form of graphite. The aggregate thickness of this matter is probably little inferior to that of coal in the Carboniferous rocks. I also showed that this graphite in its mode of occurrence resembles that of bitumen and coaly matter in more modern rocks, that it is associated with organic limestone and with deposits of iron ore, probably of organic origin, and that under the microscope some portions of it appear to show traces of vegetable fibre. Further, since we have in Rhode Island beds of coal of the true Coal-formation in part converted into graphite, and still retaining traces of organic structure, and since we have in Canada abundance of instances of bituminous schists converted into graphitic schists, there is no improbability in supposing that a similar change may have passed on the carbon of the Laurentian. From these considerations I deduced the conclusion that the Laurentian period was probably an age of most prolific vegetable growth, and in which great quantities of carbon were fixed in the rocks of the earth's crust by this agency. Whether the vegetation of the Laurentian was wholly aquatic or in part terrestrial we have no means of knowing, but it is not unreasonable to conjecture that could we find the Laurentian rocks in such condition as to show distinct organic

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* Journal of Geol. Soc. Vol. XXVI, p. 112.

forms, we might discover in them the prototypes of genera which ascend into the Devonian.[*]

3. Such views as to a primitive Silurian and Laurentian flora are strengthened by the obvious fact that the plants of the Lower and Middle Devonian have the aspect of the remains of a decaying flora verging on extinction, and pointing backward in Geological time, while those of the Upper Devonian give us a great number of new forms and point onward to the Carboniferous. As already stated the Lower and Middle Erian flora stands by itself in the prevalence of such archaic and prototypal forms as *Prototaxites*, *Psilophyton*, *Nematoxylon*, and *Arthrostigma*. Is it probable that it was thus isolated? Is it not more likely that these plants were the successors of an older and more primitive flora?

This is vividly presented to the mind in the Erian Conifers. In the Lower Sandstones of Gaspé we find numerous trunks of large trees, all having the structure of *Protataxites*. In the Hamilton Group of New York and in the sandstones of St. John, these are replaced by *Dadoxylon*, a type extending into the Carboniferous and thence to the modern Araucarian pines. There is no transition from one type to the other, nor are they intermixed in the same beds. The Middle Devonian would thus seem to have been the grave of *Prototaxites* and the birth-place of *Dadoxylon*, in so far as the regions in question are concerned.

Something of the same kind occurs in the Carboniferous, in the scanty and somewhat antique Lower Carboniferous flora pointing backward to the Upper Devonian, just as the Lower Devonian may be supposed to point backward to the Silurian.

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[*] Even before the discovery of the first specimens of *Eozoon Canadense*, and some time before the microscopic investigations of the writer had established the organic character and affinities of these fossils, Dr. T. Sterry Hunt had already in the *Amer. Jour. Science* for May, 1855 (XXV, 436) asserted that "the presence of iron ores, not less than that of graphite points to the existence of organic life even during the Laurentian or so-called Azoic period." The same argument is maintained by Dr. Hunt in the *Quar. Jour. Geol. Soc.* for 1859 (p. 493) and the *Amer. Jour. Science* for July, 1860 (XXX, 134) while in the last named Journal for May, 1861 (XXXI, 395) he says: "The great processes of deoxydation in nature are dependant upon organization; plants by solar force convert water and carbonic acid into hydrocarbonaceous substances, from whence bitumens, coal, anthracite and plumbago; and it is the action of organic matter which reduces sulphates, giving rise to metallic sulphurets and sulphur. In like manner it is by the action of dissolved organic matters that oxide of iron is partially reduced and dissolved from great masses of sediment to be subsequently accumulated in beds of iron ore. We see in the Laurentian series beds and veins of metallic sulphuresta, precisely as in more recent formations; and the extensive beds o iron-ore, hundreds of feet thick, which abound in that ancient system, correspond not only to great volumes of strata deprived of that metal, but, as we may suppose, to organic matters, which, but for their oxydation might have formed deposits of mineral carbon far more extensive than those of plumbago which we actually meet in the Laurentian strata. All these conditions lead us then to conclude the existence of an abundant vegetation during the Laurentian period.'

The above reasons lead me to anticipate with confidence the discovery in the Silurian of a flora similar in type to that of the Lower Devonian, but probably richer in species.

4. Is it possible to indicate where such earlier flora may be expected to occur? Whatever views we may adopt as to the origin of species, it is plain that land animals and plants must originate on the land, and marine animals and plants in the waters. Further, in areas liable to oscillations of level, there must be the more abrupt and sudden changes, while in quiet areas such changes may be slow and gradual. A notable example of this is afforded by the area of the Gulf of St. Lawrence. Submerged from the earliest geological times, and unaffected by the great Appalachian disturbances, it presents in the Island of Anticosti an imperceptible transition, elsewhere unexampled in Eastern America, from the Lower to the Upper Silurian. Wherever the earliest and most permanent land existed, there would be the earliest and most continuous flora. As the land extended in area the flora would extend and would be augmented. As in any period the oceanic area encroached on the land, the flora would be driven back on its old centres, and might be diminished in amount and variety. Possibly in periods of extensive submergence, it might over vast areas be destroyed altogether, and on subsequent re-emergence might in the first instance be tardily and imperfectly reproduced, or might appear under entirely new forms. Again, a slowly subsiding area would be that most favourable for the preservation of plants as fossils. An area in process of re-elevation, especially if this were rapid, would be unfavourable, and this more particularly if the previous marine condition had been very extensive.

In Eastern America, from the Carboniferous period onward, the centre of plant distribution has been the Appalachian chain. From this the plants and sediments extended westward in times of elevation, and to this they receded in times of depression. But this centre was non-existent before the Devonian period, and the centre for this must have been to the North-east whence the great mass of older Appalachian sediment was derived. In the Carboniferous period there was also an eastward distribution from the Appalachians, and links of connection in the Atlantic bed between the Floras of Europe and America. In the Devonian such connection can have been only far to the north-east. It is therefore in Newfoundland, Labrador, and Greenland that we are to look for the oldest American Flora, and in like manner on the border of the old Scandinavian nucleus for that of Europe.

Again, it must have been the wide extension of the sea of the Corniferous limestone that gave the last blow to the remaining flora of the Lower Devonian: and the re-elevation in the middle of that epoch brought in the Appalachian ridges as a new centre, and established a connection with

Europe which introduced the Upper Devonian and Carboniferous Floras. Lastly, from the comparative richness of the later Erian flora in Eastern America, especially in the St. John beds, it might be a fair inference that the North-eastern end of the Appalachian ridge was the original birthplace or centre of creation of what we may call the later Palæozoic Flora, or of a large part of that flora.

Before such probable conclusions as those above stated can be accepted as definitely established, there must be an immense amount of labour on the part of collectors and of botanists, and specimens must be brought together to compare the plants of the like epochs in the most distant localities. Further, the facts thus obtained must be put in relation with the geographical and stratigraphical distribution of successive beds, and with the distribution of the contemporary marine faunæ. Until this great work shall have been completed, we shall have no sure basis for the knowledge of the laws of introduction and extinction of species, and the Palœobotanist must be content with the thankless task of collecting facts apparently barren of geological results.

(5) *Practical Deductions.*

The value of Palæontology to the practical man and theoretical geologist can scarcely be overrated. A single characteristic fossil is often sufficient to determine the geological age of a formation, and the question of geological age is one that must be ascertained previous to any deductions whether as to the mineral contents or conditions of formation of strata.

In order to apply this test of age, it is necessary that the fossils of the different beds shall be accurately studied, described and figured. Hence in all Geological Surveys, large expenditures have been made for this object, and magnificent volumes have been published for the purpose of illustrating the fossils of the several formations, that both the scientific and practical man may have ready access to reliable sources of information. The small means at the disposal of the Canadian Survey has hitherto prevented it from going as far in this direction as is desirable, though in so far as the animal fossils of the older rocks are concerned, the publications which have been issued by Mr. Billings, the Palæontologist of the Survey, have been of the utmost utility, and have largely contributed to raise the scientific reputation of Canada abroad.

Fossil plants have hitherto been regarded as of much less importance than fossil animals in determining the ages of rocks, and in some portions of the geological series, where the formations are strictly marine, their value is no doubt quite subordinate. But there are portions of the geological formations, more especially those related to the great Carboniferous series, in which their value becomes much greater; and accordingly in the

Geological Surveys of regions in which the Carboniferous system is largely developed, they have commanded more attention than elsewhere. The State Surveys of Pennsylvania and of Illinois deserve especial mention for their attention to the Flora of the Carboniferous rocks. With regard to the special subject of the present Report, its value depends mostly on the utility of comparing the Carboniferous plants with those of older periods.

Though many valuable contributions to the Natural History of the plants older than the Carboniferous have been published in the proceedings of learned Societies and elsewhere, the present is, I believe, the first Official Report ever published on these ancient forms of vegetable life, and the first attempt to give a complete view of the oldest Flora of any large region of the earth. It is therefore not merely an important contribution to Canadian Geology, but as the Devonian Flora has many features in common over all the world, it will be of service in every country where these rocks occur, and I anticipate that it may aid in the settlement of important geological questions in very distant portions of the world.

With reference to the value of the subject in this country, I need only refer to the mistakes which have been made in confounding the Devonian with Carboniferous rocks in the search for coal. I may instance the anticipations which were excited as to the discovery of coal at Perry, in Maine, at several places in Gaspé, and in the vicinity of St. John, New Brunswick, and which in some of these places led to considerable expenditures of money; or the disputes as to the Devonian or Carboniferous age of the celebrated deposit of Albertite at Hillsborough, New Brunswick. These and similar difficulties could all have been readily settled by a reference to the evidence of fossil plants; and with the help of this Report, more especially if it should be followed by similar publications on the plants of the several stages of the Carboniferous, there will be no necessity for such errors in future.

Thus an important step will be gained in marking out the limits of the coal-bearing rocks, and in avoiding the errors which may arise from confounding their characteristic fossils with those of the older strata in which productive coal beds have not yet been found.

Further, the comparisons which can now be made between the vegetable inhabitants of the world in two principal ages of its older history, and these ages both very rich in fossil plants, will serve to throw much light on the questions now so much agitated with reference to the introduction and extinction of species in geological time. To enter on such discussions would be out of place here, but I propose elsewhere to take them up somewhat fully, using the facts of the present memoir as a basis whereon to rest my conclusions.

6.—*Revised List of the Pre-Carboniferous Plants of N. E. America, showing their Geological and Geographical Distribution.*

NAMES OF SPECIES.	Upper Silurian.	Lower Devn.	Middle Devonian.			Upper Devonian.			Carboniferous.	
	Gaspé.	Gaspé.	Gaspé, &c.	New York, &c.†	New Brunswick.	Gaspé, &c.	New York, &c.†	Maine.	Lower.	Middle and Upper.
Syringoxylon mirabile, Dawson				*						
Dadoxylon Ouangondianum, Dn,					*					
D. Halli, Dn.				*						
D. Newberryi, Dn				*						
Ormoxylon Erianum, Dn.				*						
Prototaxites Logani, Dn		*	*							
Nematoxylon crassum, Dn.			*							
N. tenue, Dn.			*							
Aporoxylon							*	*		
Sternbergia					*					
Sigillaria palpebra, Dn					*					
S. Vanuxemii, Goeppert							*			
S. simplicitas, Vanuxem.				*			*			
Syringodendron gracile, Dn.							?		*	
Stigmaria exigua, Dn.							*			
S. pusilla, Dn								*		
S. perlata, Dn.					*					
S. areolata, Dn.			*							
S. minutissima, Dn			*	*						
Didymophyllum reniforme, Dn.		*					*			
Cyperites sp				*	*			*	*	
Calamodendron antiquius, Dn.					*					
C. tenuistriatum, Dn.					*					
Calamites cannæformis, Bt.					*					
C. inornatus, Dn.			*	*			*			
C. transitionis, Goept					*					
C. sp.					*			*		
Anarthrocanna Perryana, Dn.								*		
Asterophyllites parvula, Dn.					*					
A. latifolia, Dn.					*					
A. acicularis, Dn.					*					
A. scutigera, Dn.					*					
A. lenta, Dn.					*					
Annularia laxa, Dn.			*							
Sphenophyllum antiquum, Dn.					*					
Pinnularia dispalans, Dn					*					
P. elongata, Dn.					*					
P. nodosa, Dn.					*					
Lepidodendron Gaspianum, Dn.			*	*	*	*	*	*		
L. Chemungense, Dn.							*			
L. corrugatum, Dn.							?		*	
L. primævum.							*			
Leptophleum rhombicum, Dn.			*					*		
Lepidophloios antiquus.			*							
Psilophyton princeps, Dn.	*	*	*	*	*	*	*			
P. robustius, Dn	*	*								
P. elegans, Dn.			*		*					
P. glabrum, Dn.	?	*	*		*					
Arthrostigma gracile, Dn		*	*							
Cyclostigma densifolium, Dn.			*							
Cordaites Robbii, Dn.				*	*					
C. angustifolia, Dn.		*	*	*	*					
C. sp					*					
C. sp				*						
C. flexuosus, Dn								*		
Cyclopteris Jacksoni, Dn.					*	*		*		
C. Halliana, Goeppert							*			
C. Rogersi, Dn							*	*		
C. valida, Dn.					*					
C. obtusa, Lesq.					*		*			
C. Bockshii, Goeppert					*					
C. Brownii, Dn.							*	*		
C. varia, Dn.					*					
C. problematica, Dn.					*					
Neuropteris polymorpha, Dn.					*					
N. serrulata, Dn.					*					

† Including Ohio, Pennsylvania and Ontario.

Revised List—(Continued.)

NAMES OF SPECIES.	Upper Silurian.	Lower Devn.	Middle Devonian.			Upper Devonian.			Carboniferous.	
	Gaspé.	Gaspé.	Gaspé.	New York, &c.†	New Brunswick.	Gaspé.	New York, &c.†	Maine.	Lower.	Middle and Upper.
Neuropteris Selwyni, Dn.					*					
N. Crassa, Dn					*					
N. resecta, Dn.					*					
N. new species, Dn.					*					
N. Dawsoni, Hartt					*					
Sphenopteris Hoeninghausi, Brong.					*					
S. marginata, Dn.					*					
S Hartii, Dn.					*					
S. Hitchcockiana, Dn					*					
S. recurva, Dn					*					
S. splendens, Dn.					*					
Hymenophyllites curtilobus, Dn.					*					
H subfurcatus, Dn.					*					
H. Gersdorffii, Goeppt.					*					
H. obtusilobus, Goeppt.					*					
H. Hildreti, Lesq.					*					
Alethopteris discrepans, Dn.					*					
A. ingens, Dn.					*					
A. Perleyi, Hartt					*					
Peoopteris serrulata, Dn.					*					
P. obscura, Dn.					*					
P preciosa, Hartt.					*					
P. densifolia, Dn					*					
Trichomanites sp., Dn.					*			*		
Caulopteris Lockwoodi, Dn							*	*		
" antiqua, Newberry				*			*			
Protopteris peregrina, Ny. sp.				*						
Rhachiopteris pinnata, Dn				*						
R. cyclopteroides, Dn							*			
R. punctata, Dn							*			
R. striata, Dn.				*			*			
R. tenuistriata. Dn				*						
R. gigantea, Dn.				*						
R. palmata, Dn.				*						
R. sp			*							
Psaronius Erianus, Dn				*						
P. textilis, Dn.							*			
Cardiocarpum cornutum, Dn.					*					
C. Baileyi, Hartt.					*					
C. Crampii, Hartt.					*					
C. ovale, Dn.					*					
C. obliquum, Dn.					*					
Trigonocarpum racemosum, Dn.					*					
T. perantiquum, Dn.					*					
Carpolithes siliqua, Dn								*		
C. spicatus, Dn					*					
C. lunatus, Dn								*		
C. compactus, Dn.					*					
Antholithes Devonicus, Dn.					*					
A. floridus, Dn					*					
Sporangites Huronensis, Dn.				*						
Sporangites acuminata, Dn.					*					

EXPLANATION OF THE PLATES.

Plate I. *Dadoxylon and Ormoxylon.*

Fig. 1. *Dadoxylon Ouangondianum*,—Transverse section of a calcified specimen, showing rings of growth and radiating structure, natural size.
2. ———— Longitudinal section, radial, showing discigerous wood-cells, and medullary rays, 100 diams.
3. ———— Longitudinal section, tangential, showing wood-cells and medullary rays.
4. ———— Portion of wood-cell, showing hexagonal areolation and pores, 30 diameters.
5. *Dadoxylon Halli*,—Longitudinal section, showing wood-cells, (discigerous), and medullary ray.
6. ———— Portion of wood-cell showing areolation and pores, 300 diameters.
7. *Dadoxylon Newberryi*,—Longitudinal section, radial, showing discigerous wood-cells and medullary ray.
8. ———— Longitudinal section, tangential, showing wood-cells and medullary rays, 100 diameters.
9. ———— Portion of wood-cell showing areolation and pores, 100 diameters.
10. *Ormoxylon Erianum*,—Carbonized stem with casts of pith cavities (a, a) natura size.
11. ———— Wood-cell showing areolation and medullary ray, 100 diameters.
12. ———— Portion of wood-cell, showing areolation and pores, 300 diameters.
13. ———— Portion of wall of cell showing one areole and pore, 600 diameters.
14. ———— Restored stem—(a) pith cavities, (b) cellular pith, (c) wood.
15. ———— Longitudinal section of Sternbergia pith of *Dadoxylon Ouangondianum* showing a tendency to division into lenticular spaces, similar to those of Ormoxylon. The dark lines represent the phragmata coal escing towards the centre. Twice natural size. 15a one of the phragmata of this Sternbergia showing the vacant space in the centre.
16. ———— Longitudinal section of pith of the modern *Cecropia peltata*, showing partitions and spaces (a, a). Natural size.
17. Longitudinal section of Sternbergia pith of *Dadoxylon materiarium* from the coal formation, showing the arrangement of the phragmata, natural size.

Plate II. *Prototaxites.*

Fig. 18. *Prototaxites Logani*,—Fragment 19 inches in length from a large trunk; inner side showing rings of growth; surfaces at a, a, edges at b.
19. ———— Fragment from a trunk 3 ft. in diameter, and showing the outer surface, with transverse ribs and marks of insertion of branches at a, a. Actual width of the fragment 2 feet.
20. ———— Transverse section showing the wood-cells, and a medullary ray at (a, a). 100 diameters.
21. ———— Transverse section, showing wood-cells, medullary ray (a, a) and ring of growth (b). 100 diameters.
22. ———— Longitudinal section, showing the extremity of a medullary ray—tangential section, 100 diameters.
23. ———— Transverse section, the wood-cells seen imperfectly at a, a, but for the most part obscured by concretionary structure.
24. ———— Longitudinal section, showing wood cells, 100 diameters.
25. ———— Transverse section, showing medullary rays at a, a, and line of growth at b, b, 20 diameters.

Fig. 26. *Prototaxites Logani*,—Three wood-cells, showing spiral fibres and obscure pores at a, a, 300 diameters.
27. ——— Transverse section of portion of root, 100 diameters.

PLATE III. *Sternbergia*, *Stigmaria*, *Didymophyllum*, *Cyperites*, *Calamodendron*.

Fig. 28. *Sternbergia Pith*,—probably of *Dadoxylon*, from Lepreau, nat. size.
29. ——— From St. John, showing indications of the wood at the sides, (a, a).
30. *Stigmaria exigua*,—Specimen from Elmira, N.Y., half nat. size; 30a, areole enlarged.
31. *Stigmaria pusilla*,—Specimen from Perry, Maine, nat. size.
32. *Stigmaria perlata*,—Specimen from St. John, shewing remains of rootlets at a, a, 32a, one of the areoles.
33 *Stigmaria areolata*,—Specimen from Gaspé.
34. *Stigmaria minutissima*,—Specimen from Gaspé; 34a, areole enlarged.
35. *Didymophyllum reniforme*,—Specimen from N. York; 35a. areole enlarged.
36 and 37. *Cyperites*,—(leaves of Sigillaria) St. John.
38. *Cyperites*,—Perry, Maine.
39. *Calamodendron antiquius*,—Specimen from Lepreau, showing remains of woody cylinder at a, a.
40. *Calamodendron tenuistriatum*,—Specimen from Lepreau.

PLATE IV. *Calamites*.

Fig. 41. *Calamites transitionis*,—Flattened stem; 41a, areole of the same.
42. ——— Branch with leaves; 42a, leaf restored; 42b, leaf magnified, showing transverse markings.
43 and 45. ——— Small stems or branches, with leaves.
44. ——— Stem with leaves.
46. ——— Diagram of ribs and scars.
47. *Calamites cannæformis*,—Base of stem, showing ribs and areoles, 47a, areole enlarged.
48. ——— Diagram of ribs and areoles.
49. *Calamites* sp,—Fragment showing ribs with remains of outer envelope at a and b.

PLATE V. *Asterophyllites*, *&c*.

Fig. 50. *Asterophyllites latifolia*,—Branch with pinnæ bearing whorls of leaves.
51. ——— Branch with whorls of larger leaves; 51a, leaf showing form and venation.
52. ——— Termination of a stem or branch.
53. ——— Portion of fructification.
54. *Asterophyllites acicularis*,—Branch with pinnules bearing whorls of leaves; 54a Separate leaf; 54b. annulus uniting leaves; 54c, part of a whorl o larger leaves.
55 and 56. ——— Fructification.
57. ——— Fragment of stem.
58. *Asterophillites sculigera*,—58a, node showing the scales or tubercles.
59. ——— Terminal bud or fructification.
60. *Asterophyllites lenta*,—Stem and leaves; 60a, separate leaf.
61. *Sphenophyllum antiquum*,—Branch with whorls of leaves.
62. ——— Leaflet enlarged. Natural size at b.
63. Sheath or whorl of bracts. Nat. size and enlarged.

PLATE VI. *Annularia laxa*, *&c*.

Fig. 64. *Annularia laxa*,—Scattered whorls and stems.
65, 66, 67, 68. ——— Separate whorls.
69. ——— Portion of whorl enlarged, showing venation.

Fig. 70. *Annularia laxa*,—Slab with radiating roots; 70a, appearance of these on vertical edge of slab.
71. ———— Irregular roots from underclay.
72. Radiating roots or frond. 72 a. Another specimen.
73. Disc-like body on same slabs with *A. laxa;* 73a, the same enlarged.

Plate vii. *Pinnularia, &c.*

Fig. 74. *Pinnularia dispalans*,—a, a, areoles.
75. ———— Fragment showing axis and ramification enlarged.
76. ———— Fragment enlarged, showing areole.
77. *Pinnularia elongata.*
78. *Pinnularia nodosa*,—78a, portion showing nodose margin.
79. *Psilophyton glabrum*,—Showing internal axis ; 89a. portion enlarged.
80. Similar branch of *P. robustius.* 80 a. Petiole of Fern.
81. *Lycopodites Richardsoni*,—a, cone; b, leafy stem.

Plate viii. *Lepidodendron, &c.*

Fig. 82. *Lepidodendron Gaspianum*,—decorticated branch.
83. ———— Branch with leaves; 83a, areoles enlarged.
84. ———— Branch with fructification.
84 a. *Lepidodendron Chemungense*, reduced.
85. *Lycopodites Matthewi*,—85a, leaf enlarged.
86. ———— Stem with leaf scars enlarged.
87. ———— showing ramification.
88. *Leptophleum rhombicum*,—Impression of a stem, showing areoles.
89. ———— Flattened stem, showing areoles and leaf scars below, and Sternbergia structure above, 89a, areole and scar.
90. *Lepidophloios antiquus*,—Stem or branch showing scars; 90 a. b, leaf of this or a similar species.
91. ———— Portion of the same from a photograph ; 91 a, b, areoles enlarged.
92. *Cyclostigma densifolium*,—Stem natural size.
93 to 95, —— Portions of stem showing remains of leaves and scar of branch or cone at a.
96. ———— Areoles in various conditions.

Plate ix. *Psilophyton princeps.*

Fig. 97, 98 *Psilophyton princeps*, var *ornatum*, leafy stems.
99. ———— Larger stems.
100. ———— Smaller branches.
101. ———— Circinate termination.
102, 103. —— Branches with fructification.
104. ———— Stem with leaves enlarged; 104a, leaf enlarged.
105, 106. —— Fructification.
107. ———— Spore-cases enlarged, showing slit.
108. ———— Spore-cases further enlarged, showing slit at a.
109, 110. —— Smaller branches, enlarged.

Plate x. *Psilophyton.*

Fig. 111. Slab with rhizomata of *Psilophyton princeps* from an underclay, (a. a,) areoles.
112 to 114. Circinate terminations of young branches of *Psilophyton.*
115 and 116. Areoles of rhizoma of *Psilophyton.*
117. *Rhizoma of Psilophyton* showing ramenta and areoles; 117a form of the areoles.

Fig. 118. *Psilophyton princeps*, decorticated branch with fruit.
119. ——— Fragments of branchlets.
120 ——— Portion of rhizoma giving off stems.
121. *Psilophyton robustius*,—Fragment with Fruit.
122. Branchlets of *Psilophyton elegans*.
123. Portion of a branch of the same enlarged.
124 and 125. *Carpolites?* from Devonian Gaspé.
126. Carpolite or concretion do do.

PLATE XI. *Psilophyton, &c.*

Fig. 127. *Psilophyton princeps*,—Restored section of magnified stem, showing, (a) scalariform axis, (b) woody cylinder, (c) cellular cylinder, (d) outer, fibrous cylinder.
128. ——— Scalariform vessels and woody fibres, 120 diameters; 128a woody fibres 300 diams; 128b scalariform vessels, 300 diams; 128c cellular matter, 300 diams.
129. ——— Leaf magnified showing striæ; 129a, portion more magnified, showing cellular structure and stoma.
130. *Psilophyton robustius*,—Scalariform tissue, 100 diameters; 130a, portion more magnified.
131. ——— Transverse section magnified, showing scalariform axis and bark.
132. ——— Portion of the same more magnified.
133. *Psilophyton princeps*,—Rhizoma, transverse sections showing axis, nat. size.
134. ——— The same magnified; 134a, scalariform tissue; 134b, woody fibres; 134c bark fibres, 100 diams.
135. *Nematoxylon tenue*,—Cross section of stem natural size, showing coaly bark and wood.
136. ——— Longitudinal section, 100 diams; (a) transverse section 100 diams (b, c,) cells more magnified.
137. *Nematoxylon crassum*,—Longitudinal section, 100 diams; (a) transverse section 100 diams; (b) single cell more magnified.

PLATE XII. *Psilophyton robustius.*

Fig. 138. *Psilophyton robustius*,—Stems and fructification.
139. ——— Branch and fructification.
140. ——— Mass of spore cases.
141. ——— Spore cases in different aspects.
142 to 144. — Surface of stem enlarged.
145. ——— Portion of stem showing impression of the axis.

PLATE XIII. *Arthrostigma gracile.*

Fig. 146. *Arthrostigma gracile*,—Leafy stems flattened; 146a, leaves enlarged.
147. ——— Stem giving off lateral branches.
148 to 150. — Fragments of stems showing leaves, areoles (a) and internal axis (b).
151 and 152 — Erect stems with leaves, 157a, areoles enlarged.
153. ——— Section of erect stems with leaves.
154. ——— Fructification, supposed to be of this species.
155. ——— Stem partially restored.

PLATE XIV. *Cordaites, &c.*

Fig. 156. *Cordaites Robbii*,—Part of a large leaf; 156a, venation enlarged.
157. ——— Point of a leaf, crushed.
158. ——— Point of a leaf.
159 and 160.— Clasping bases of leaves.

Fig. 161. *Cordaites Robbii*,—Part of a leaf with shells of Spirorbis; 161a and b, shells enlarged.

162. *Cordaites Robbii*,—Leaf folded and crushed.

163. *Cordaites augustifolia*,—Leaves in shale, 163a, portion enlarged; 163b, bases of leaves attached to stem; 166c, leaf showing venation.

164. ———— Broad variety or species; 164a, portion enlarged showing venation.

165. *Cordaites*,—165a, portion enlarged, showing venation.

166. ———— Cylindrical roots of Psilophyton, passing horizontally through a bed

166a. ————Cylindrical roots passing vertically.

Plate XV. *Cyclopteris, &c.*

Fig. 167. *Cyclopteris* (*Archæopteris*) *Jacksoni*,—167a, terminal pinnule showing venation. 167b, lateral pinnules, Perry, Maine.

168. Pinnæ of the same, Gaspé.

169. Pinnæ of the same, Montrose, Pennsylvania.

170. Pinnule *Archæopteris Halliana.*

171. Pinnule *Archæopteris Rogersi.*

172. *Cyclopteris Brownii.*

173 and 174. *Cyclopteris*(*Nephropteris*) *problematica.*

175. *Sphenopteris Hitchcockiana*,—This species may probably be founded on fertile pinnæ of Cyclopteris Jacksoni; 165a pinnules enlarged.

Plate XVI. *Sphenopteris, Hymenophyllites, &c.*

Fig. 176 and 177. *Sphenopterus Harttii*; 177a, portion enlarged.

178. and 179. *Hymenophyllites curtilobus*; 179a, portion enlarged.

180. *Hymenophyllites sub-furcatus*; 180a, portion enlarged.

181. *Hymenophyllites Hildreti*; 181a, portion enlarged.

182. *Hymenophyllites Gersdorffii*; 182a, portion enlarged.

183. *Hymenophyllites obtusilobus.*

184. *Sphenopteris marginata*; 184a, portion enlarged.

185. *Sphenopteris Hoeninghausi.*

186. *Sphenopteris splendens*; 186a, portion enlarged.

187. *Cyclopteris* (*Aneimites*) *Bockshii*; 187a, pinnule, showing veins.

188. *Cyclopteris* (*Aneimites*) *obtusa*; 188a, pinnule, showing veins.

189. *Callipteris pilosa*; 189a, Pinna enlarged, showing hairy surface; 189b, fertile pinna enlarged; 189c, pinnule showing venation, enlarged; 189d fertile pinnule enlarged.

190. *Cyclopteris* (*Aneimites*) *valida*, pinnule nat. size. (See Acad. Geol. Fig. 192.)

Plate XVII. *Neuropteris, &c.*

Fig. 191. *Neuropteris* (*Megalopteris*) *Dawsoni*,—191a, venation.

192. ———— Portion of a large pinnule split at the margin.

193. ———— Portion of a pinnule, apex.

194. ———— Two small pinnules.

195 and 196. *Pecopteris densifolia*; 196a, pinnule enlarged.

197. *Neuropteris retorquata*; 197a, pinnule enlarged.

198. *Neuropteris Selwyni*; 198a, pinnule showing veins.

199. *Neuropteris*; 199a, pinnule showing veins.

200. *Neuropteris crassa*; 200a, venation.

201 and 202. *Cyclopteris* (*Neuropteris*) *varia*, 202a, venation.

Plate XVIII. *Neuropteris and Alethopteris.*

Fig. 203. *Alethopteris discrepans*,—Broad variety.

Fig. 204. *Alethopteris discrepans*—Narrow variety; 204a to c, venation.
205. ———— Small lateral pinna.
206. *Alethopteris ingens*,—Venation, natural size.
207 and 208. *Pecopteris serrulata*,—208a, b, venation.
209. ———— Large specimen.
210. *Pecopteris preciosa*,—Small variety.
211. ———— Large variety, 211a, pinnule enlarged.
212. *Neuropteris polymorpha*.—212a, pinnule showing venation.
213. *Neuropteris serrulata*,—Pinnule showing venation, enlarged.

PLATE XIX. *Fruits, &c.*

Fig. 214 to 215. *Cardiocarpum cornutum*,—Different sizes and states of preservation.
216. ———— Specimen enlarged, showing corrugated nucleus and tegmen.
217. ———— Specimen enlarged, showing indications of cotyledons.
218. ———— Specimen enlarged, showing thickened testa and foramen at a; 218b, specimen enlarged showing foramen in usual state of preservation.
219. *Cardiocarpum Baileyi.*
220. to 221. *Cardiocarpum Crampii.*
222. ———— Enlarged, showing nucleus and outer coat with foramen.
223. *Cardiocarpum ovale.*
224. ———— Enlarged, showing nucleus and outer coat.
225. *Cardiocarpum obliquum.*
226. ———— Specimen enlarged.
227. *Trigonocarpum racemosum*,—Nucleus, nat. size and enlarged; 227a, same on peduncle.
228. *Trigonocarpum perantiquum*,—Outer coat; 228a, nucleus, deprived of coat.
229. *Carpolithes compactus.*
230 and 231. Fruits or bracts of uncertain nature.
232. Sporangia of *Psilophyton?* (*Sporangites accuminata.*)
233 and 234. The same enlarged.
235. *Antholithes Devonicus*; 235a, terminal portion; 235b, c, portions enlarged.
236. *Antholithes floridus*; 236a, portion enlarged.

PLATE XX. *Upper Silurian Plants.*

Fig. 237 and 238. Fragments of Fucoids.
239. Stem with woody axis.
240 to 241. Rhizomata of *Psilophyton*, showing areoles and ramenta.
242. Sections of a specimen, showing the axis; 242a, b, Scalariform tissue of the same.
243 to 245. Fragments of stems of *Psilophyton robustius*.

SUPPLEMENTARY SECTION

ON THE BEARING OF DEVONIAN BOTANY ON QUESTIONS AS TO THE ORIGIN AND EXTINCTION OF SPECIES.

[The theoretical views contained in this section, though necessary to give completeness to the subject, are not suitable for an official report, and are, therefore, printed separately by the author, for circulation to those who may be interested in them as matters of science.]

FOSSIL plants are almost proverbially uncertain with reference to their accurate determination, and have been regarded as of comparatively little utility in the decision of general questions of palæontology. This results principally from the fragmentary condition in which they have been studied, and from the fact that fragments of animal structures are more definite and instructive than corresponding portions of plants.

It is to be observed, however, that our knowledge of fossil plants becomes accurate in proportion to the extent to which we can carry the study of specimens in the beds in which they are preserved, so as to examine more perfect examples than those usually to be found in museums. When structures are taken into the account, as well as external forms, we can also depend more confidently on our results. Farther, the abundance of specimens to be obtained in particular beds often goes far to make up for their individual imperfection. The writer of these pages has been enabled to avail himself very fully of these advantages; and on this account, if on no other, feels entitled to speak with some authority on theoretical questions.

It is an additional encouragement to pursue the subject that, when we can obtain definite information as to the successive floras of any region, we thereby learn much as to climate, and vicissitudes in regard to the extent of land and water; and that, with reference to such points, the evidence of fossil plants, when properly studied, is, from the close relation of plants to those stations and climates, even more valuable than that of animal fossils.

It is necessary, however, that in pursuing such enquiries we should have some definite views as to the nature and permanence of specific forms, whether with reference to a single geological period, or to successive periods; and I may be excused for stating here some general principles, which I think important for our guidance, with special reference to the palæozoic floras which form the subject of this memoir.

(1.) Botanists proceed on the assumption, vindicated by experience, that, within the period of human observation, species have not materially varied or passed into each other. We may make, for practical purposes, the same assumption with regard to any given geological period, and may hold that for each such period there are specific types, which, for the time at least, are invariable.

(2.) When we inquire what constitutes a good species for any given period, we have reason to believe that many names in our lists represent merely varietal forms or erroneous determinations. This is the case even in the modern flora; and in fossil floras, through the poverty of specimens, their fragmentary condition and various states of preservation, it is still more likely to occur. Every revision of any group of fossils detects numerous synonyms, and of these many are incapable of detection without the comparison of large suites of specimens.

(3.) We may select from the flora of any geological period certain forms, which I shall call *specific types*, which may for such period be regarded as unchanging. Having settled such types, we may compare them with similar forms in other periods, and such comparisons will not be vitiated by the uncertainty which arises from the comparison of so-called species which may, in many cases, be mere varietal forms, as distinguished from specific types. Our types may be founded on mere fragments, provided that these are of such a nature as to prove that they belong to distinct forms which cannot pass into each other, at least within the limits of one geological period.

(4.) When we compare the specific types of one period with those of another immediately precedent or subsequent, we shall find that some continue unchanged through long intervals of geological time, that others are represented by allied forms regarded either as varietal or specific, and as derived or otherwise, according to the view which we may entertain as to the permanence of species. On the other hand, we also find new types not rationally deducible on any theory of derivation from those known in other periods. Farther, in comparing the types of a poor period with those of one rich in species we may account for the appearance of new types in the latter by the deficiency of information as to the former; where many new types appear in the poorer period this conclusion seems less probable. For example, new types appearing in poor formations, like the Lower Erian and Lower Carboniferous, have greater significance than if they appeared in the Middle Erian or in the Coal Measures.

(5.) When specific types disappear without any known successors, under circumstances in which it seems unlikely that we should have failed to discover their continuance, we may fairly assume that they have become extinct, at least locally; and where the field of observation is very extensive, as in the great coal fields of Europe and America, we may esteem such extinction as practically general, at least for the northern hemisphere. When many specific types become extinct together, or in close succession, we may suppose that such extinction resulted from physical changes; but where single types disappear, under circumstances in which others of similar habit continue, we may not unreasonably conjecture that, as Pictet has argued in the case of animals, such types may have been in their own nature limited in duration, and may have died out without any external cause.

(6.) With regard to the *introduction* of specific types we have not as yet a sufficient amount of information. Even if we freely admit that ordinary specific forms, as well as mere varieties, may result from derivation, this by no means excludes the idea of primitive specific types originating in some other way. Just as the chemist, after analyzing all compounds and ascertaining all allotropic forms, arrives at length at certain elements not mutually transmutable or derivable, so the botanist and zoologist must expect sooner or later to arrive at elementary specific types, which, if to be accounted for at all, must be explained on some principle distinct from that of derivation. The position of many modern biologists, in presence of this question, may be logically the same with that of the ancient alchemists with reference to the chemical elements, though the fallacy in the case of fossils may be of more difficult detection. Our business at present, in the prosecution of palæobotany, is to discover, if possible, what are elementary or original types, and, having found these, to enquire as to the law of their creation.

(7.) In prosecuting such questions geographical relations must be carefully considered. When the floras of two successive periods have existed in the same region, and under circumstances that render it probable that plants have continued to grow on the same or adjoining areas throughout these periods, the comparison becomes direct, and this is the case with the Erian and Carboniferous floras in North-Eastern America. But when the areas of the two formations are widely separated in space, as well as in time, any resemblances of facies that we may observe may have no connection whatever with an unbroken continuity of specific types.

I desire, however, under this head, to affirm my conviction that, with reference to the Erian and Carboniferous floras of North America and of Europe, the doctrine of "homotaxis," as distinct from actual contemporaneity, has no place. The succession of formations in the Palæozoic period evidences a similar series of physical phenomena on the grandest scale throughout the northern hemisphere. The succession of marine animals implies the continuity of the sea-bottoms on which they lived. The head-quarters of the Erian flora in America and Europe must have been in connected or adjoining areas in the North Atlantic. The similarity of the Carboniferous flora on the two sides of the Atlantic, and the great number of identical species, proves a still closer connection in that period. These coincidences are too extensive and too frequently repeated to be the result of any accident of similar sequence at different times, and this more especially as they extend to the more minute differences in the features of each period, as, for instance, the floras of the Lower and Upper Devonian, and of the Lower, Middle, and Upper Carboniferous.

Another geographical question is that which relates to centres of dispersion. In times of slow subsidence of extensive areas, the plants inhabiting such areas must be narrowed in their range and often separated from each other in detached spots, while, at the same time, important climatal changes must also occur. On the re-emergence of the land such of these species as remained would again extend themselves over their former areas of distribution, in so far as the new climatal and other conditions would permit. We would naturally suppose that the first of the above processes would tend to the elimination of varieties, the second, to their increase; but, on the other hand, the breaking up of a continental flora into that of distinct islets, and the crowding together of many forms, might be a process fertile in the production of some varieties if fatal to others.

Farther, it is possible that these changes of subsidence may have some connection with the introduction, as well as with the extinction, even of specific types. It is certain, at least, in the case of land plants, that such types come in most abundantly immediately after elevation, though they are most abundantly preserved in periods of slow subsidence. I do not mean, however, that this connection is one of cause and effect; there are, indeed, indications that it is not so. One of these is, that in some cases the enlargement of the area of the land seems to be as injurious to terrestrial species as its diminution.

Applying the above considerations to the Erian and Carboniferous floras of North America, we obtain some data which may guide us in arriving at general conclusions. The Erian flora is comparatively poor, and its types are in the main similar to those of the Carboniferous. Of these types a few only re-appear in the Middle Coal formation under identical forms; a great number appear under allied forms; some altogether disappear. The Erian flora of New Brunswick and Maine occurs side by side with the Carboniferous of the same region; so does the Erian of New York and Pennsylvania with the Carboniferous of those states. Thus we have data for the comparison of successive floras in the same region. In the Canadian region we have, indeed, in direct sequence, the floras of the Upper Silurian, the Lower, Middle, and Upper Erian, and the Lower, Middle, and Upper Carboniferous, all more or less distinct from each other, and affording an admirable series for comparison in a region whose geographical features are very broadly marked. All these floras are composed in great part of similar types, and probably do not indicate very dissimilar general physical conditions, but they are separated from each other by the great subsidences of the Corniferous limestone and the Lower Carboniferous limestone, and by the local but intense subterranean action which has altered and disturbed the Erian beds towards the close of that period. Still, none of these changes was universal. The Corniferous limestone is absent in Gaspé, and probably in New Brunswick, where, consequently, the Erian flora could continue undisturbed during that long period. The Carboniferous limestone is absent from the slopes of the Appalachians in Pennsylvania, where a retreat may have been afforded to the Upper Erian and Lower Carboniferous floras. The disturbances at the close of the Erian were limited to those eastern regions where the great limestone-producing subsidences were unfelt, and, on the other hand, are absent in Ohio, where the subsidences and marine conditions were almost at a maximum.

Bearing in mind these peculiarities of the area in question, we may now group in a tabular form the distinct specific types recognized in the Erian system, indicating, at the same time, those which are represented by identical species in the Carboniferous, those represented by similar species of the same general type, and those not represented at all. For example, *Calamites cannæformis* extends as a species into the Carboniferous; *Asterophyllites latifolia* does not so extend, but is represented by closely allied species of the same type; *Prototaxites* disappears altogether before we reach the Carboniferous.

TABLE OF ERIAN AND CARBONIFEROUS SPECIFIC TYPES.

Erian Types.	Represented in Carboniferous—	
	by identical types.	by related forms.
1. Syringoxylon mirabile		
2. Nematoxylon		
3. Prototaxites		
4. Aporoxylon		
5. Ormoxylon		
6. Dadoxylon		•
7. Sigillaria Vanuxemii		•
8. S. palpebra		•
9. Didymophyllum		
10. Calamodendron		•
11. Calamites transitionis	•	
12. C cannæformis	•	
13. Asterophyllites scutigera		
14. A. latifolia		•
15. Annularia laxa		
16. Sphenophyllum antiquum		•
17. Cyclostigma		
18. Arthrostigma		
19. Lepidodendron Gaspianum		•
20. L. Veltheimianum		•
21. Lycopodites Matthewi		•
22. L. Richardsoni		
23. L. Vanuxemii		
24. Lepidophloios antiquus		•
25. Psilophyton princeps		
26. P. robustius		
27. Cordaites Robbii		•
28. C. augustifolia		
29. Cyclopteris (Archæopteris)		
30. C. (Aneimites)		•
31 C. Brownii		
32. C. varia		•
33. Neuropteris polymorpha		•
34. N. Serrulata		•
35. N. Dawsonii		
36. N. retorquata		•
37. N. resecta		
38. Sphenopteris Hœninghausi	•	
39. S. Harttii		•
40. Hymenophyllites curtilobus		
41. H. obtusilobus		•
42. Alethopteris discrepans		•
43. Pecopteris serrulata		•
44. P. preciosa		
45. Trichomanites		•
46. Callipteris		•
47. Psaronius		•
48. Cardiocarpum		•
49. C. Crampii		
50. Antholithes		•
51. Trigonocarpum		•

Of the above forms, fifty-one in all, found in the Erian of Eastern America, all, except the four last, are certainly distinct specific types. Of these only four reappear in the Carboniferous under identical species, but no less than twenty-six reappear under representative or allied forms, some at least of which a derivationist might claim as modified descendants. On the other hand nearly one half of the Devonian types are unknown in the Carboniferous, while there remain a very large number of Carboniferous types not accounted for by anything known in the Devonian. Farther, a very poor flora, including only two or three types, is the predecessor of the Erian flora in the Upper Silurian, and the flora again becomes poor in the Upper Devonian and Lower Carboniferous. Every new species discovered must more or less modify the above statements, and the whole Erian flora of America, as well as the Carboniferous, requires a thorough comparison with that of Europe before general conclusions can be safely drawn. In the meantime I may indicate the direction in which the facts seem to point, by the following general statements :—

1. Some of the forms reckoned as specific in the Devonian and Carboniferous may be really derivative races. There are indications that such races may have originated in one or more of the following ways :—(1) By a natural tendency in synthetic types to become specialized in the direction

of one or other of their constituent elements. In this way such plants as *Arthrostigma* and *Psilophyton* may have assumed new varietal forms. (2) By embryonic retardation or acceleration,* whereby certain species may have had their maturity advanced or postponed, thus giving them various grades of perfection in reproduction and complexity of structure. The fact that so many Erian and Carboniferous plants seem to be on the confines of the groups of Acrogens and Gymnosperms may be supposed favourable to such exchanges. (3) The contraction and breaking up of floras, as occurred in the Middle Erian and Lower Carboniferous, may have been eminently favourable to the production of such varietal forms as would result from what has been called the "struggle for existence." (4) The elevation of a great expanse of new land at the close of the Middle Erian and the beginning of the Coal period, would, by permitting the extension of species over wide areas and fertile soils, and by removing the pressure previously existing, be eminently favourable to the production of new, and especially of improved, varieties.

2. Whatever importance we may attach to the above supposed causes of change, we still require to account for the origin of our specific types. This may forever elude our observation, but we may at least hope to ascertain the external conditions favourable to their production. In order to attain even to this it will be necessary to inquire critically, with reference to every acknowledged species, what its claims to distinctness are, so that we may be enabled to distinguish specific types from mere varieties. Having attained to some certainty in this, we may be prepared to inquire whether the conditions favourable to the appearance of new varieties were also those favourable to the creation of new types, or the reverse—whether these conditions were those of compression or expansion, or to what extent the appearance of new types may be independent of any external conditions, other than those absolutely necessary for their existence. I am not without hope that the further study of fossil plants may enable us thus to approach to a comprehension of the laws of the creation, as distinguished from those of the continued existence of species.

In the present state of our knowledge we have no good ground either to limit the number of specific types beyond what a fair study of our material may warrant, or to infer that such primitive types must necessarily have been of low grade, or that progress in varietal forms has always been upward. The occurrence of such an advanced and specialized type as that of *Syringoxylon*, in the Middle Devonian, should guard us against these errors. The creative process may have been applicable to the highest as well as to the lowest forms, and subsequent deviations must have included degradation as well as elevation. I can conceive nothing more unreasonable than the statement sometimes made that it is illogical or even absurd to suppose that highly organized beings could have been produced except by derivation from previously existing organisms. This is begging the whole question at issue, depriving science of a noble department of inquiry on which it has as yet barely entered, and anticipating by unwarranted assertions conclusions which may perhaps suddenly dawn upon us through the inspiration of some great intellect, or may for generations to come baffle the united exertions of all the earnest promoters of natural science. Our present attitude should not be that of dogmatists, but that of patient workers content to labour for a harvest of grand generalizations which may not come till we have passed away, but which, if we are earnest and true to nature and its Creator, may reward even some of us.

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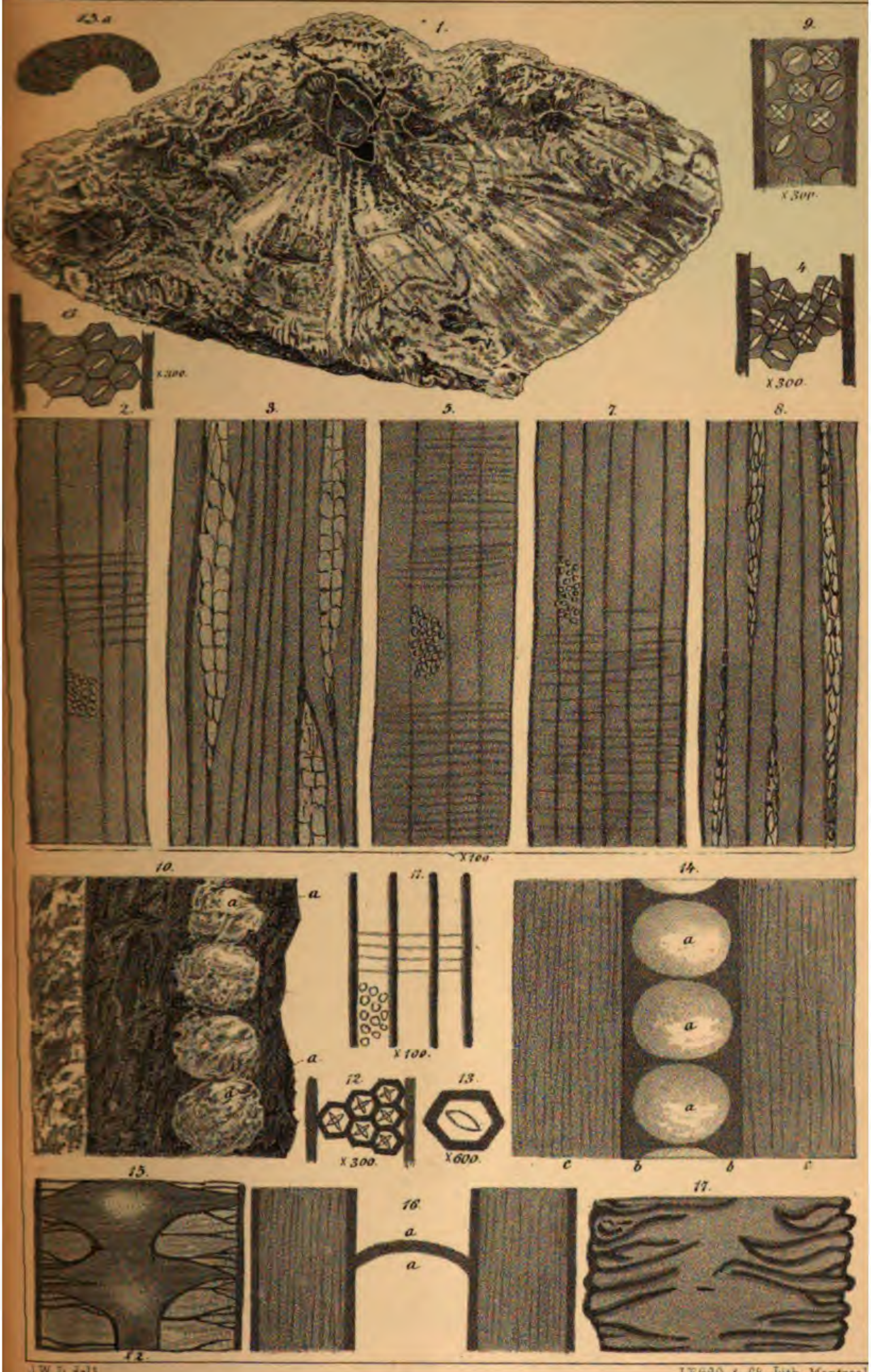
* In the manner illustrated by Hyatt and Cope.



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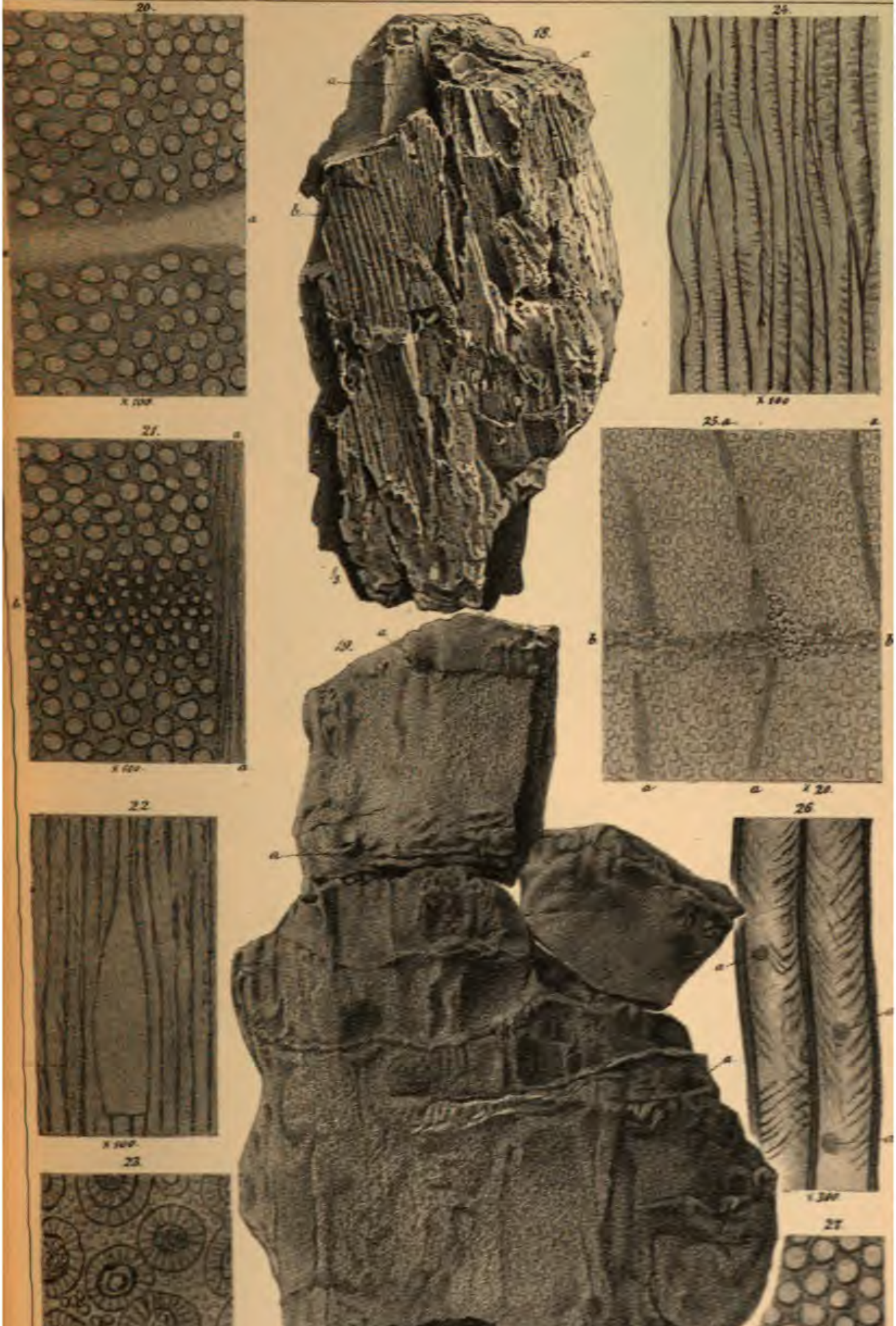
DADOXYLON, ORMOXYLON.



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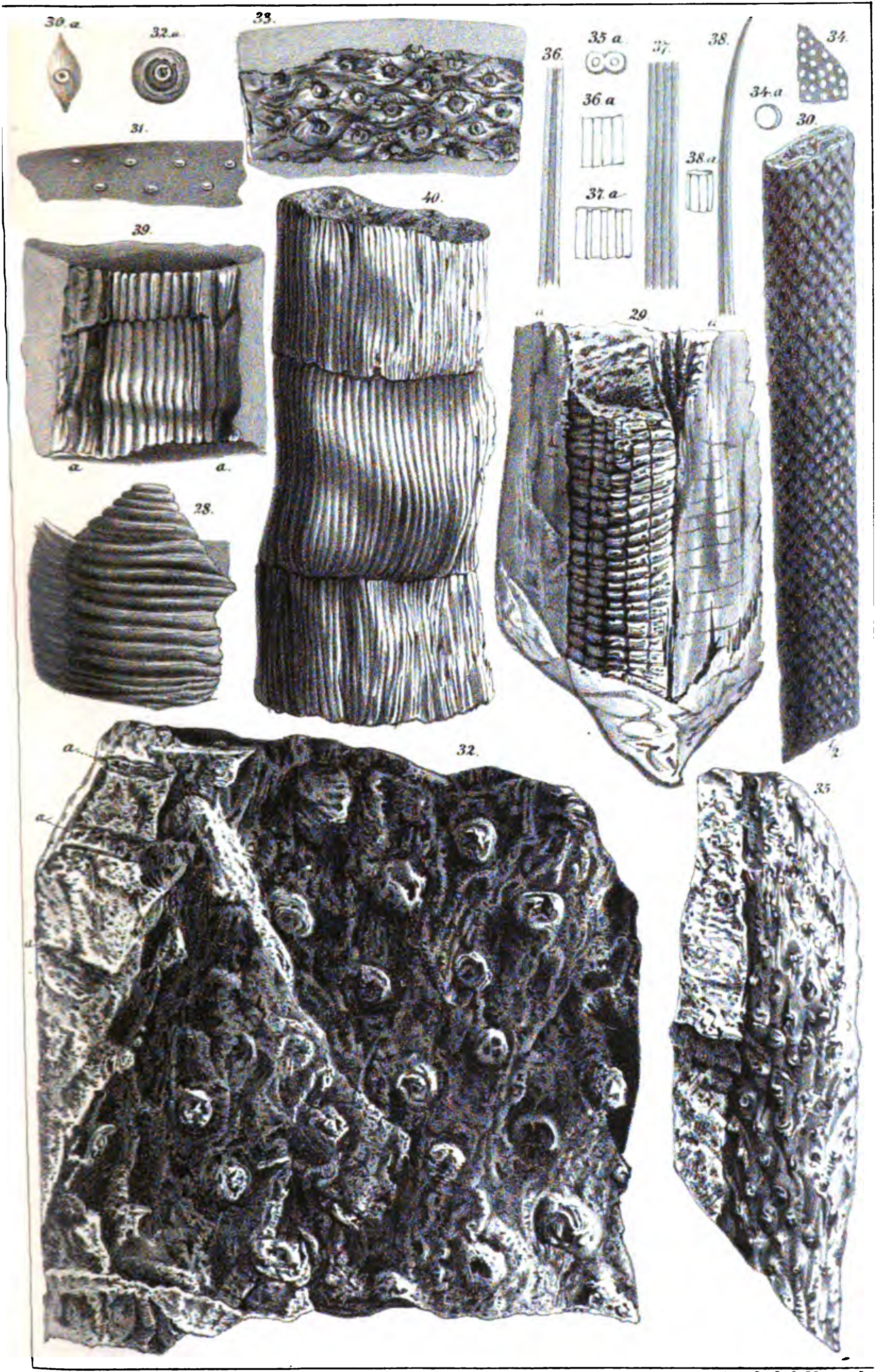

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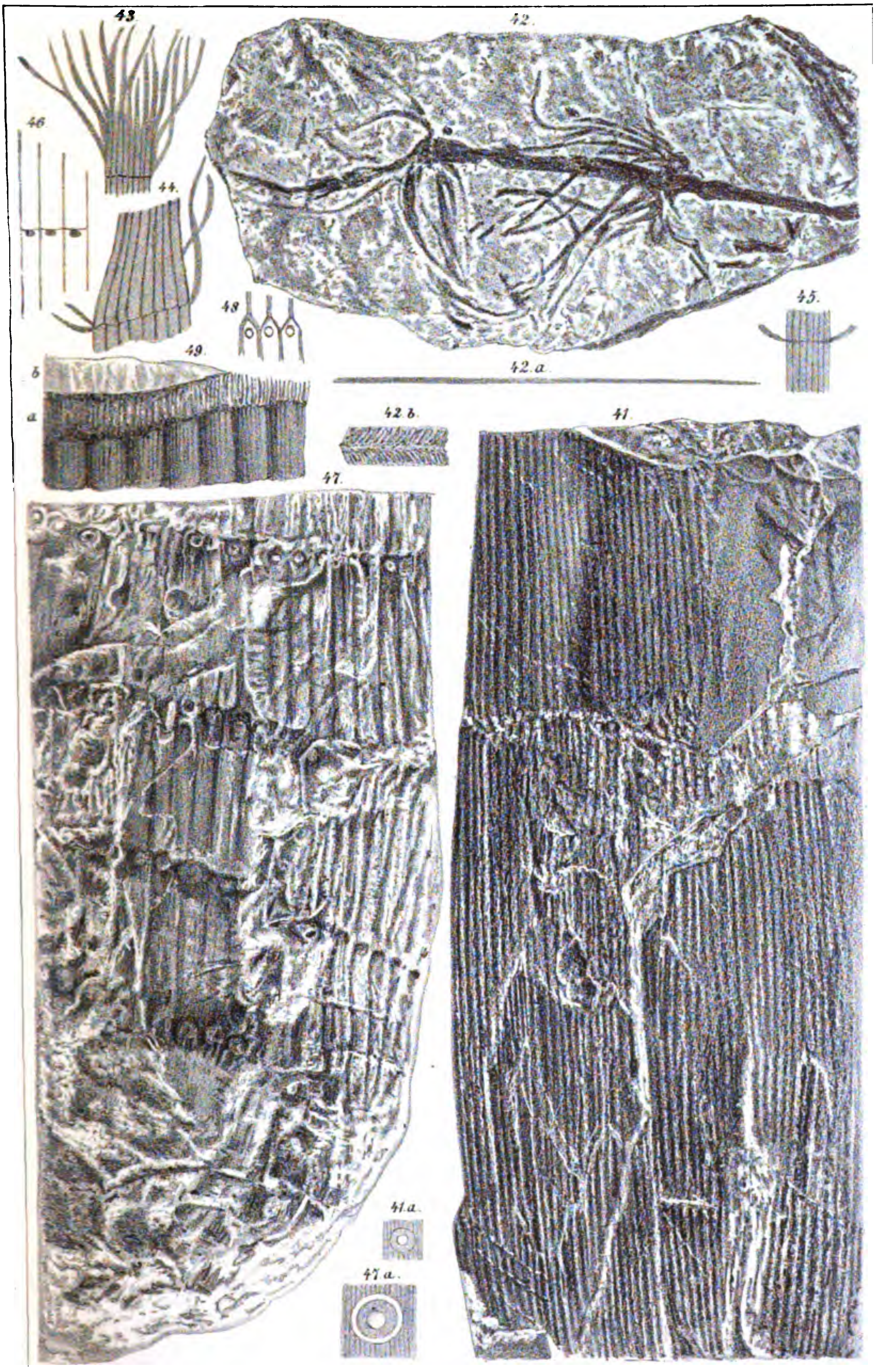
CALAMODENDRON, STERNBERGIA, STIGMARIA, DIDYMOPHYLLUM, CYPERITES



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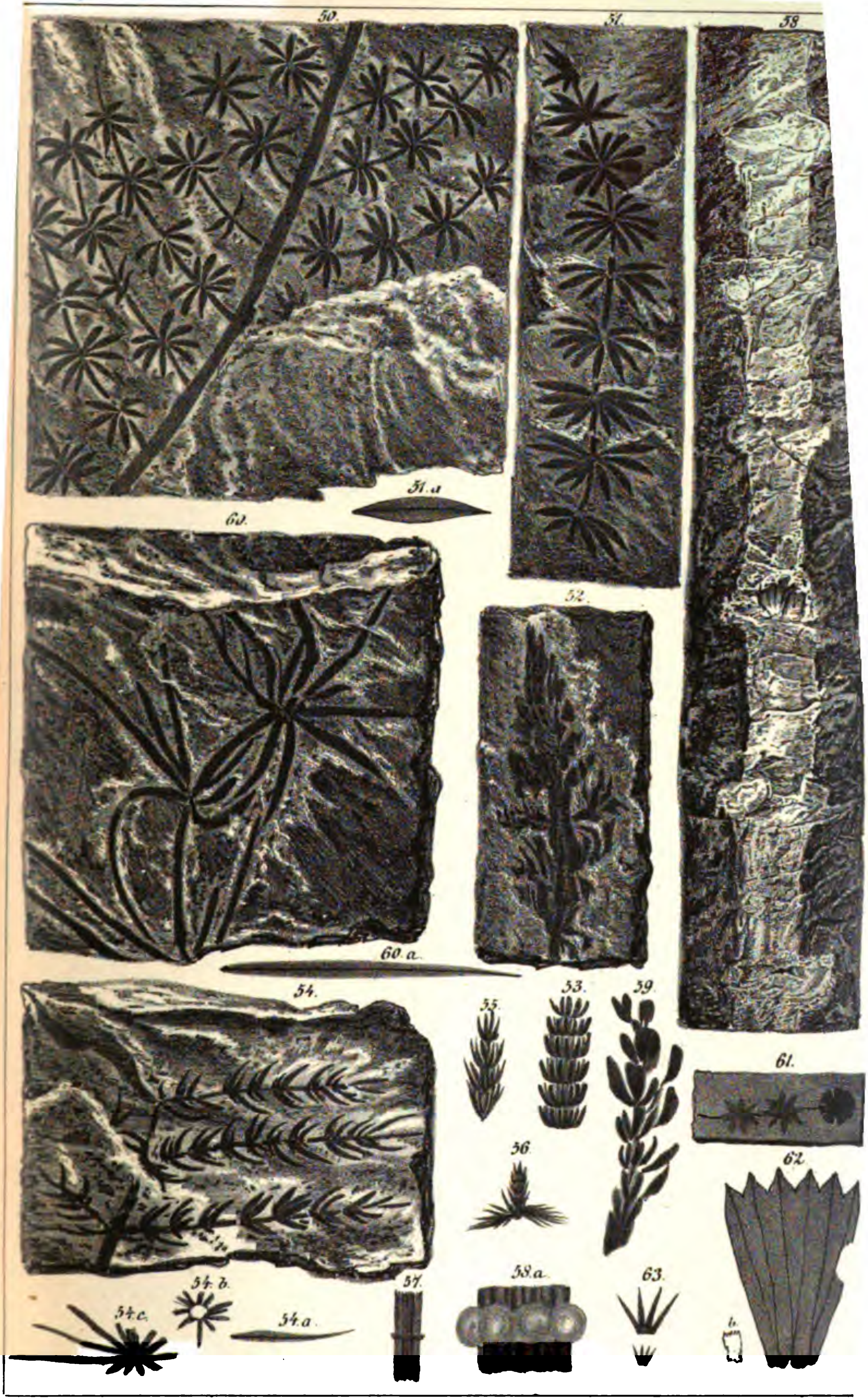
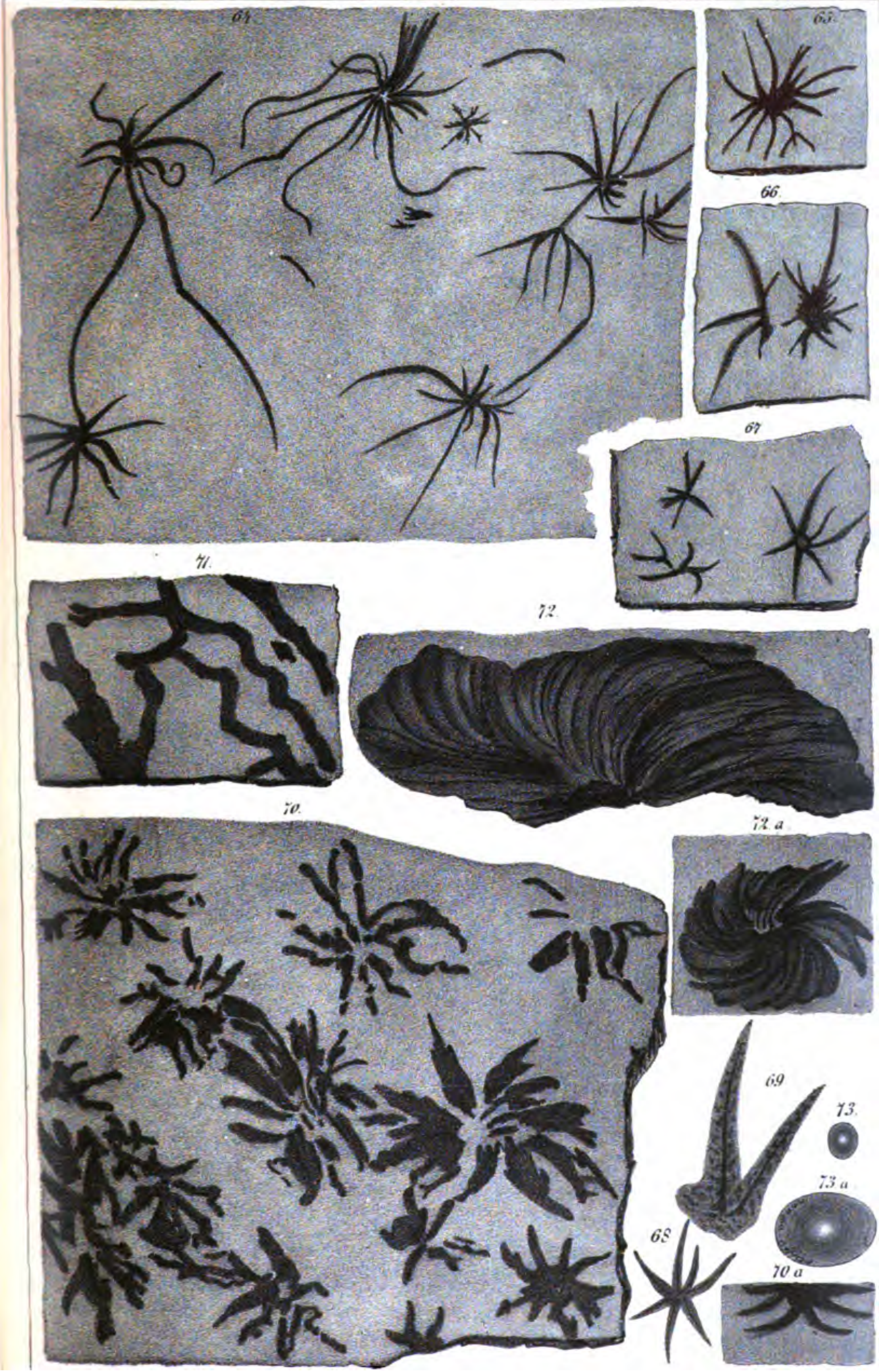
CALAMITES.



ASTEROPHYLLITES AND SPHENOPHYLLUM.



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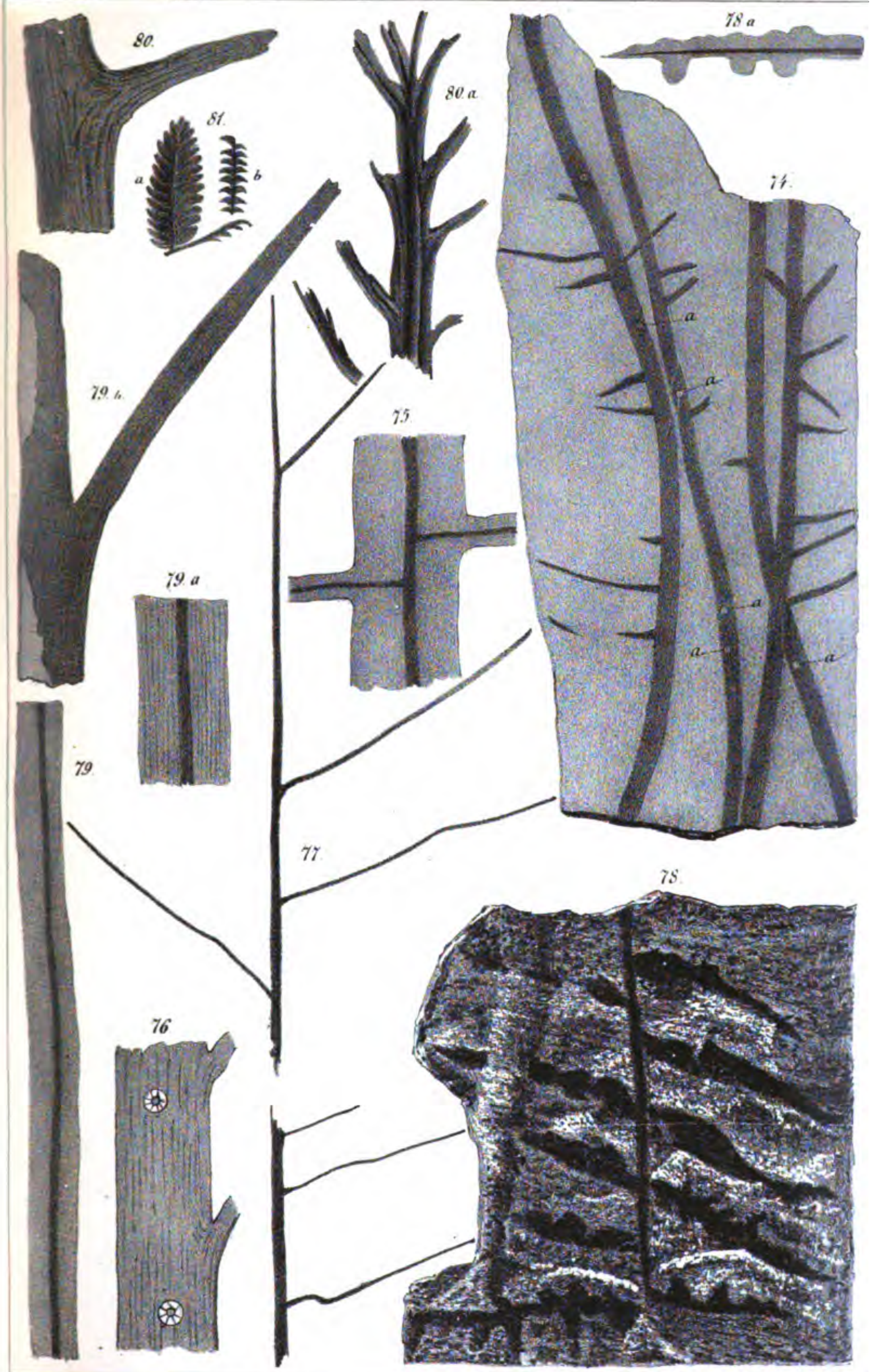
ANNULARIA, &c.



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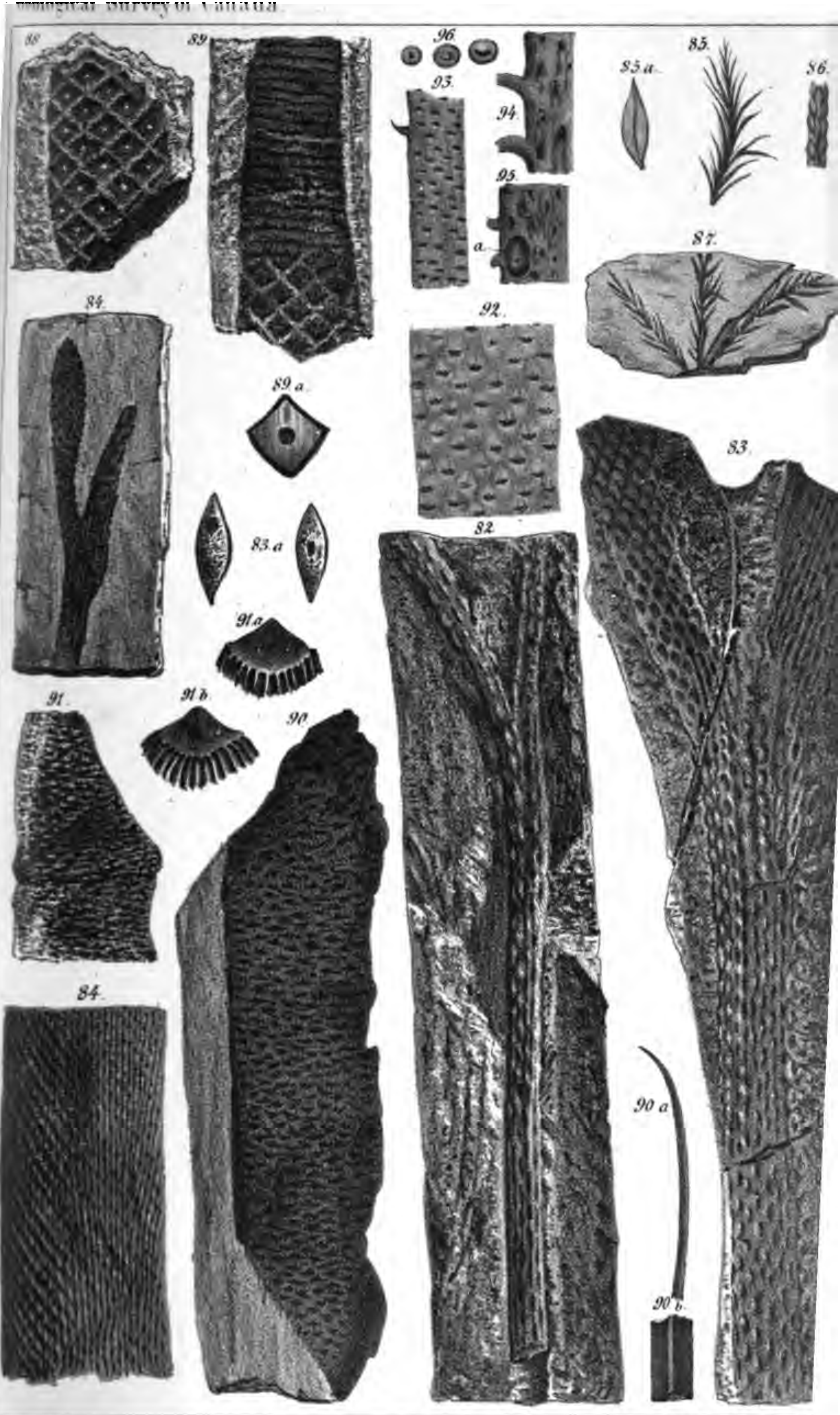
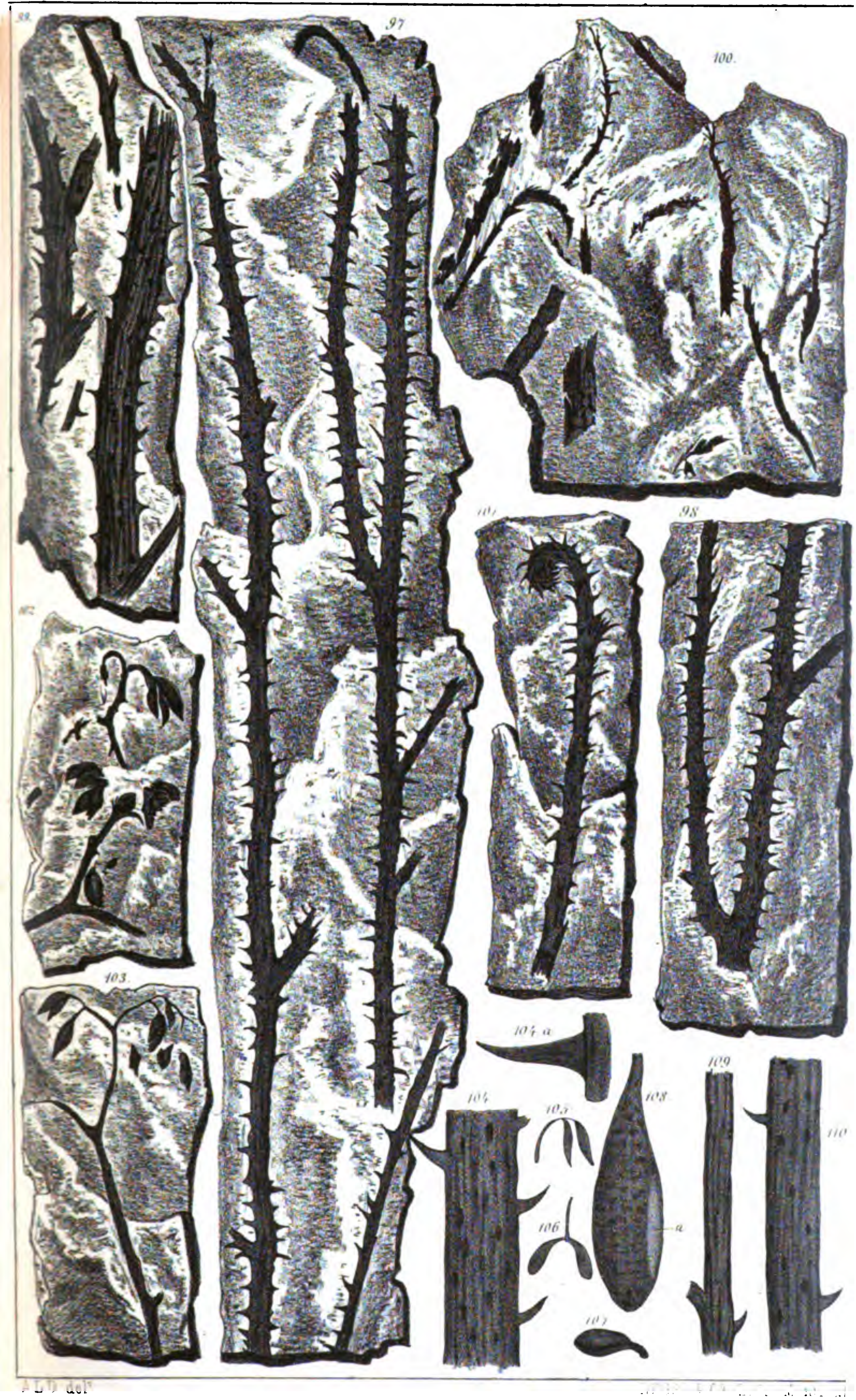
PINNULARIA, &c.



LEPIDODENDRON. LYCOPODITES, &c.



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PSILOPHYTON PRINCEPS.

Geological Survey of Canada

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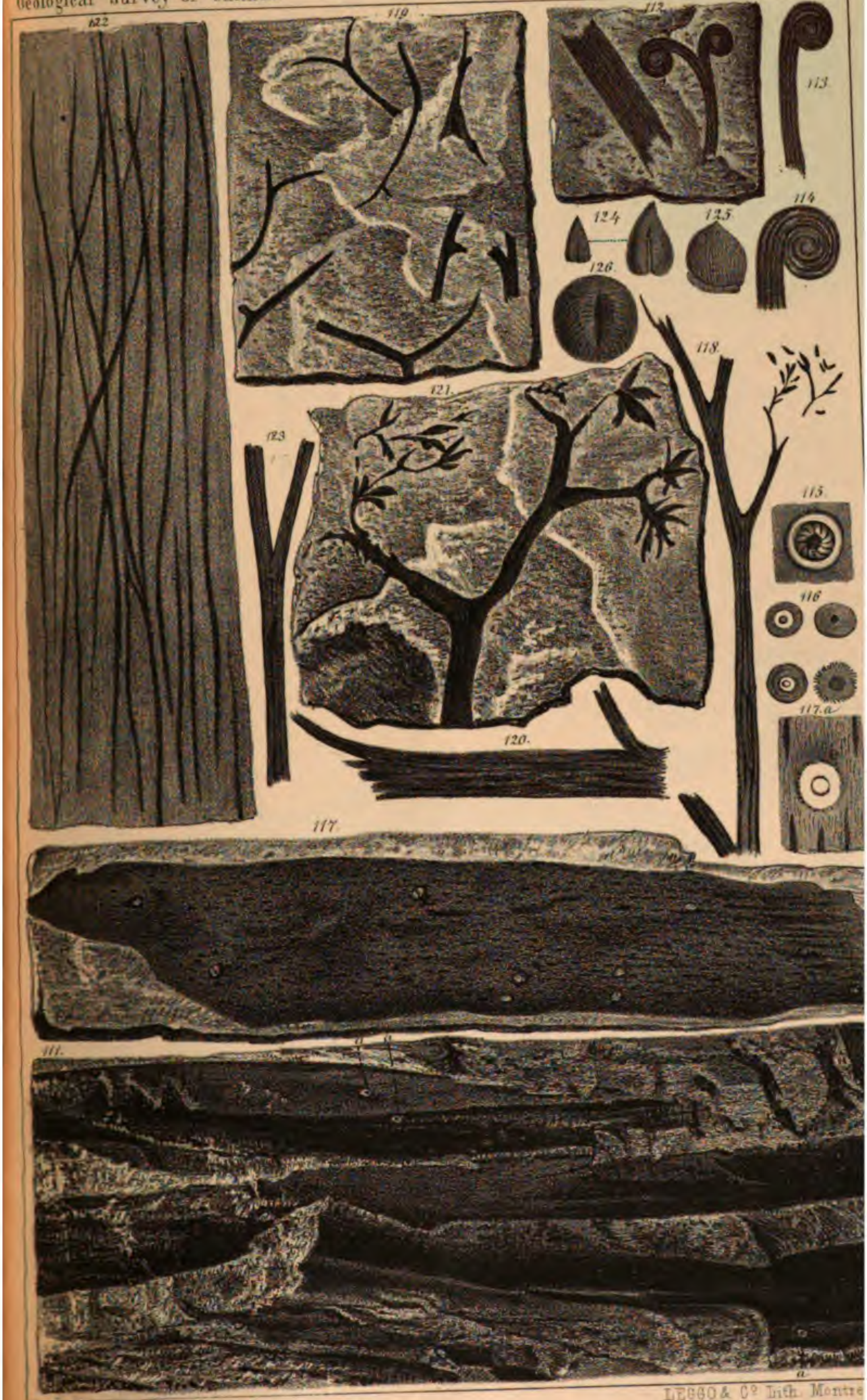

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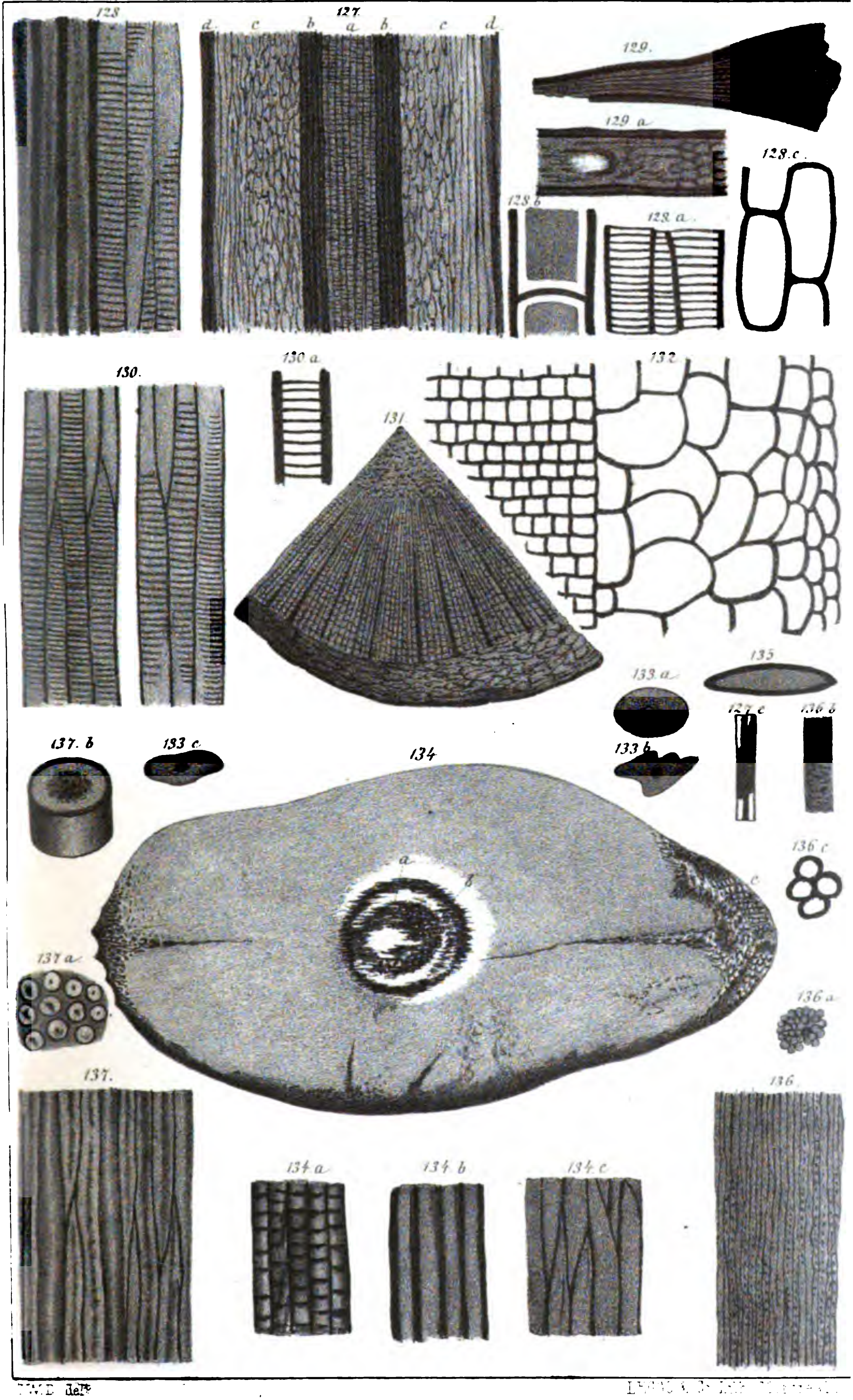
PSILOPHYTON.



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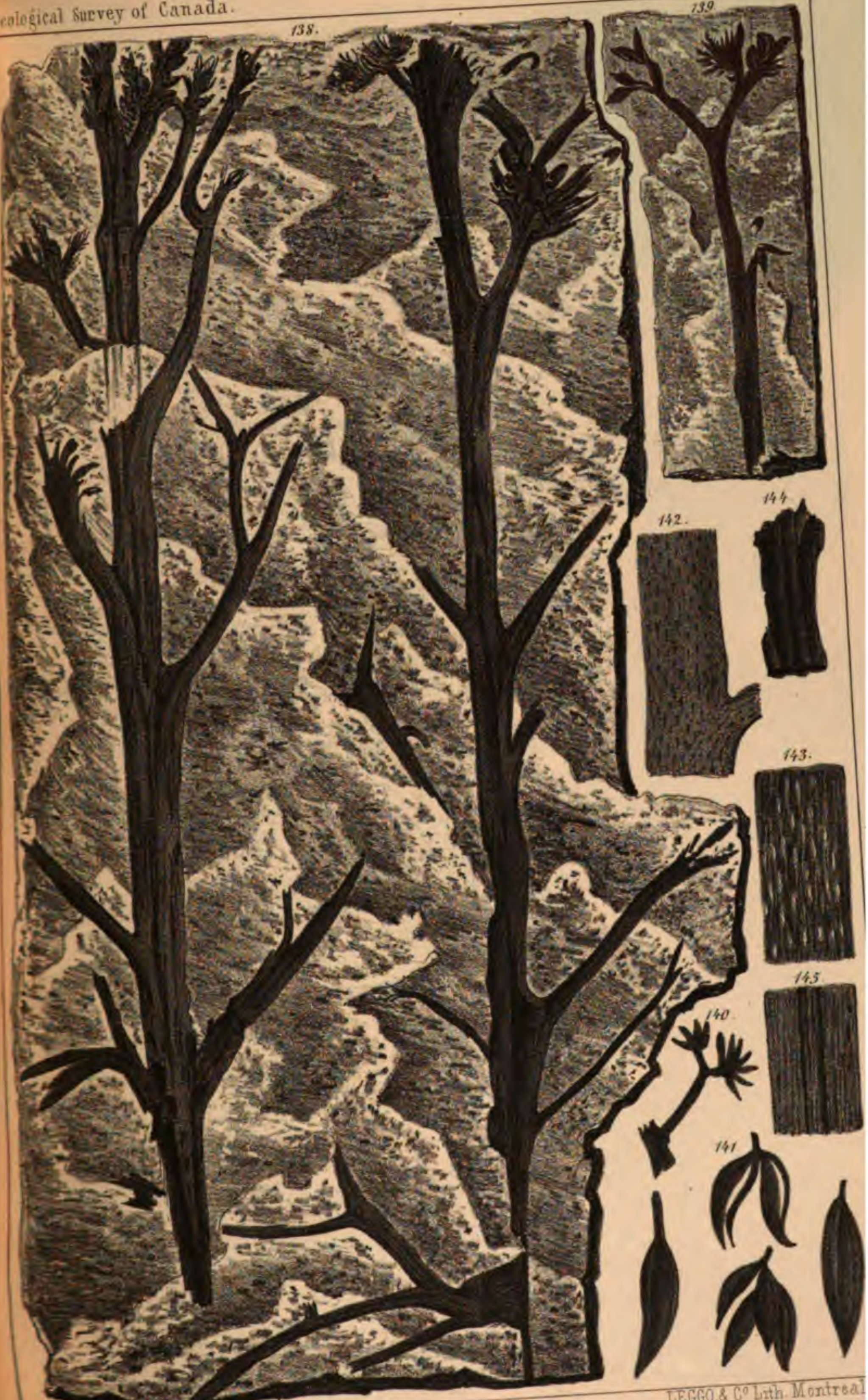
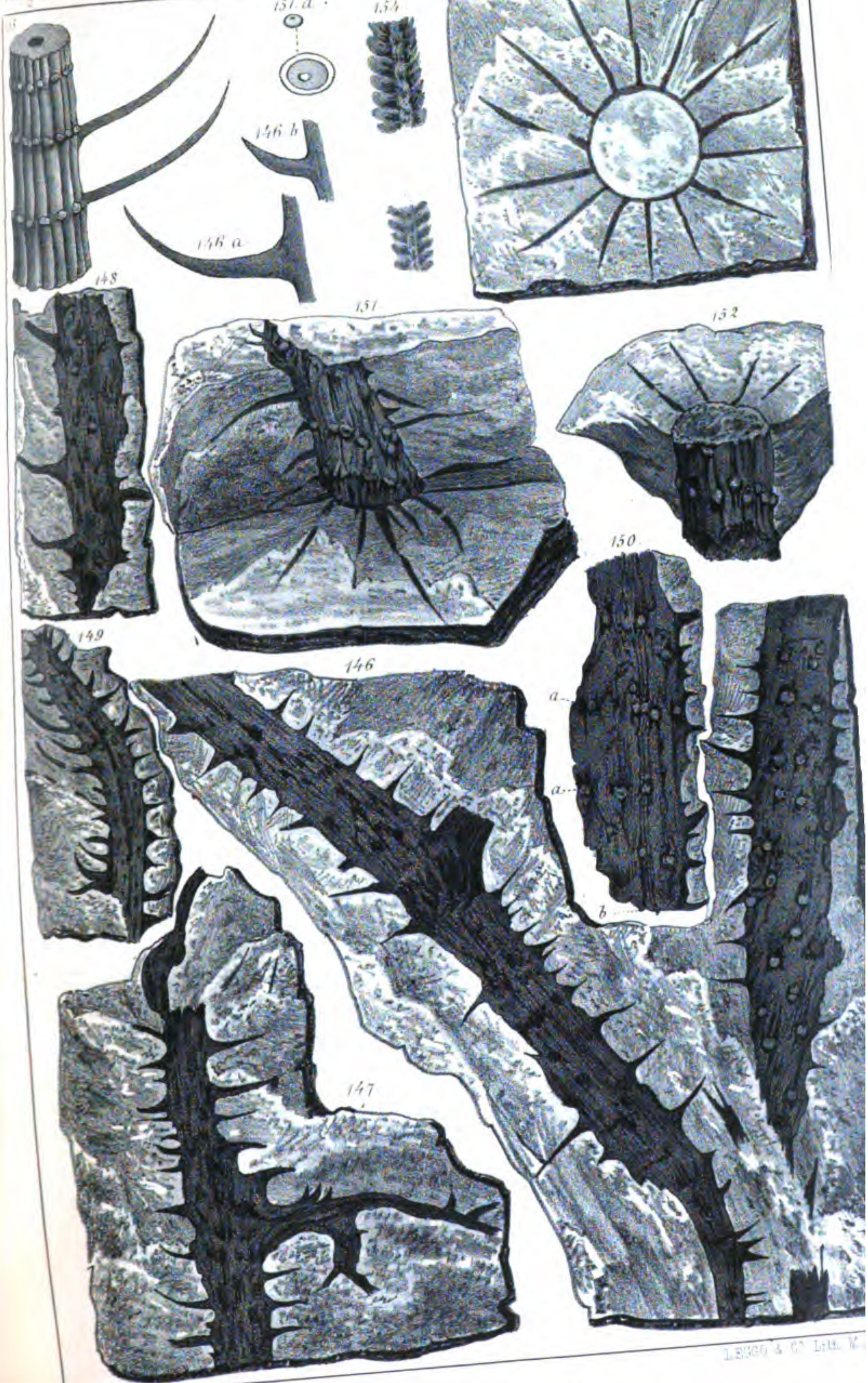
PSILOPHYTON AND NEMATOXYLON.



A. L. D. del.

LEGGO & Cº Lith. Montreal

PSILOPHYTON ROBUSTIUS.



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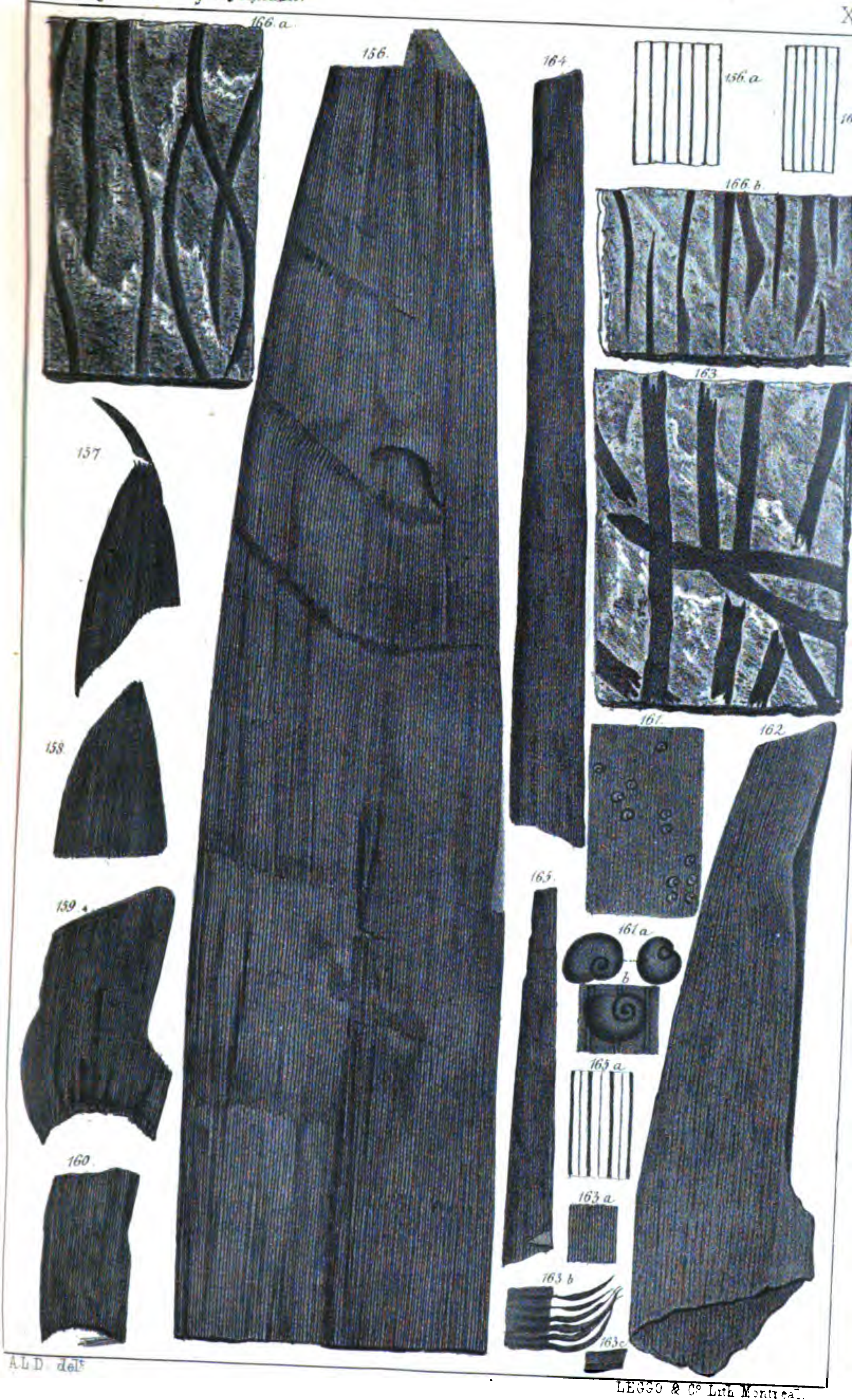

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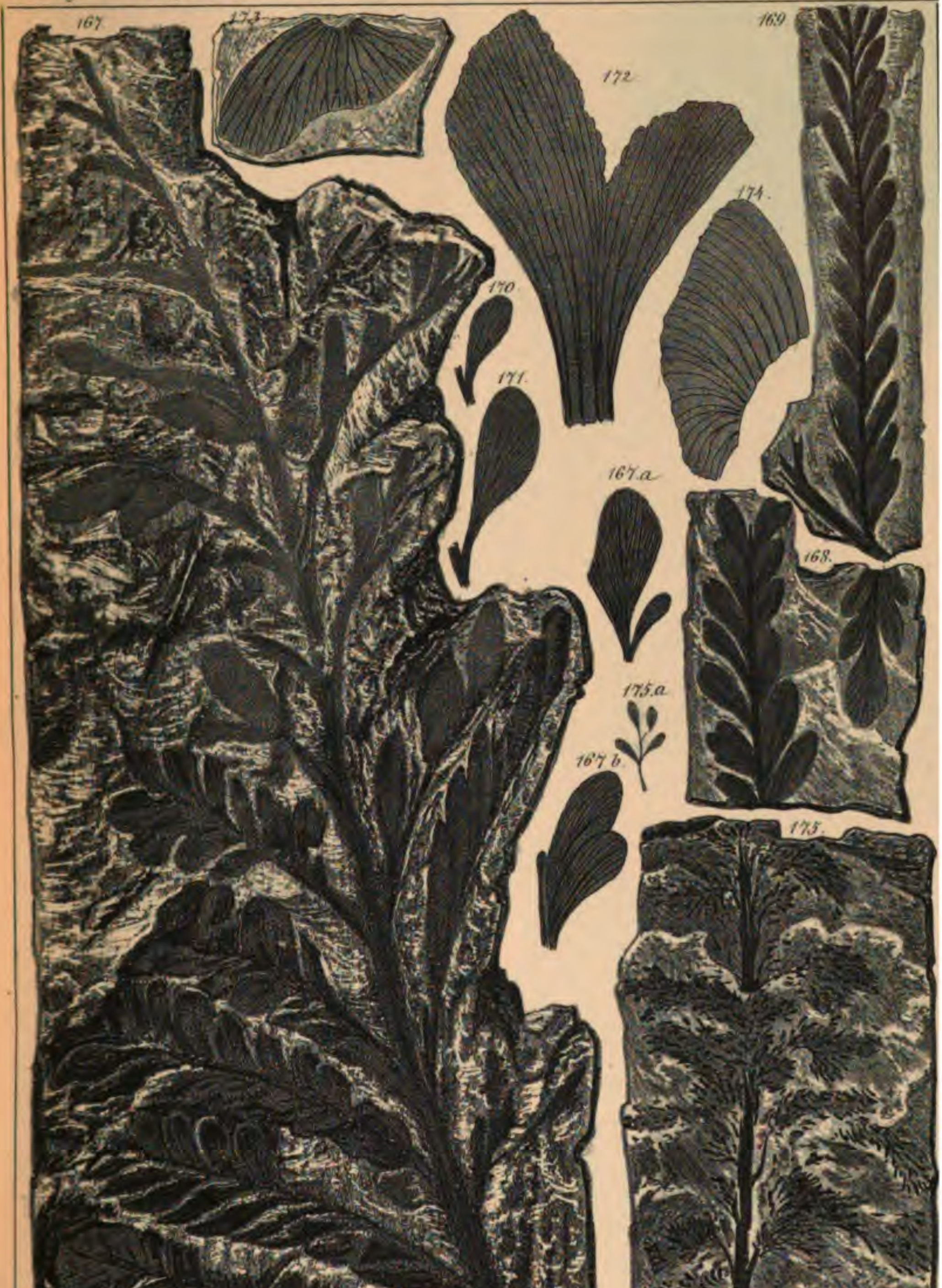
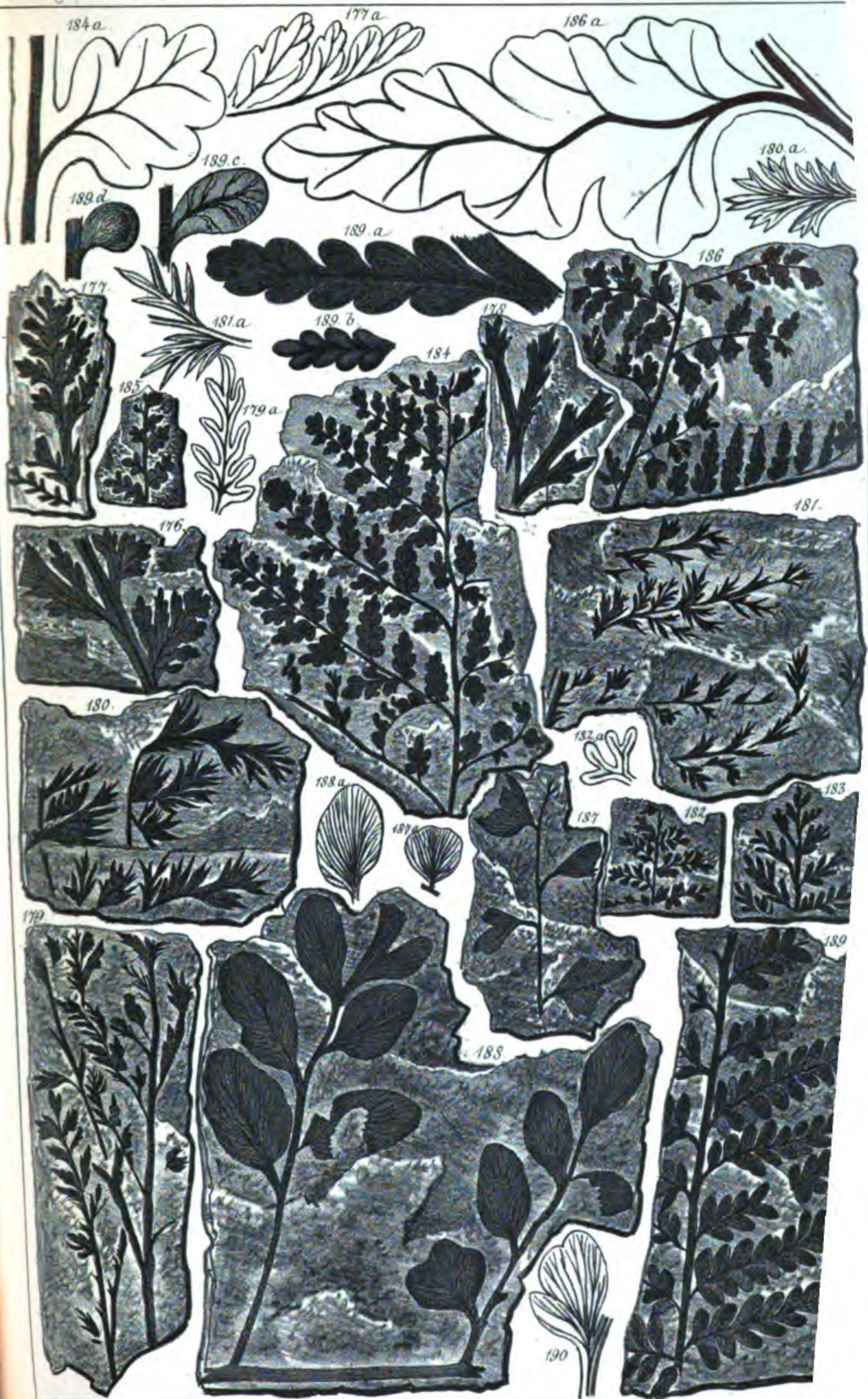
LEGGO & Co Lith Montreal.

CORDAITES, &c.



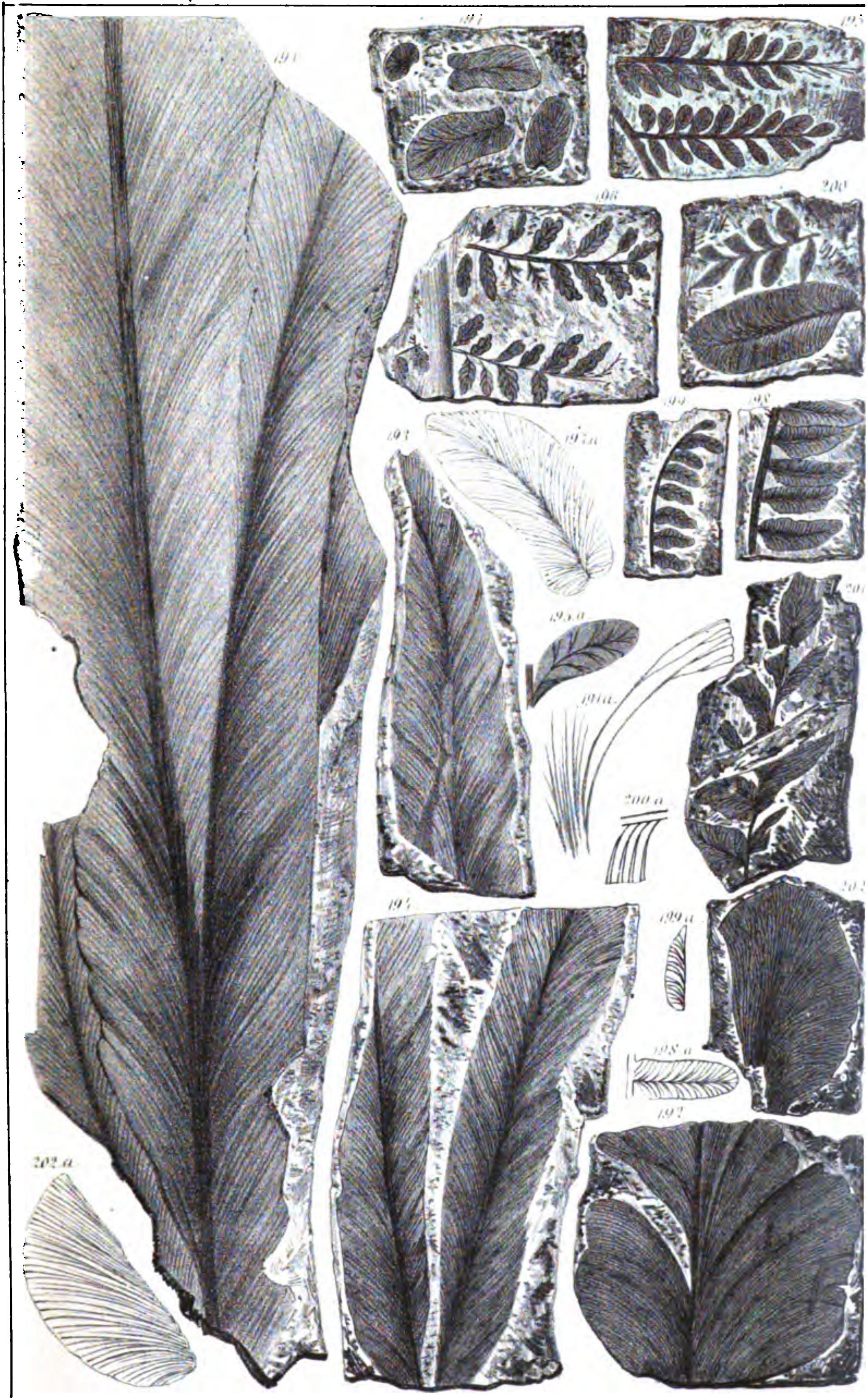
A.L.D. del^t LEGGO & C^o Lith. Montreal

CYCLOPTERIS, &c.

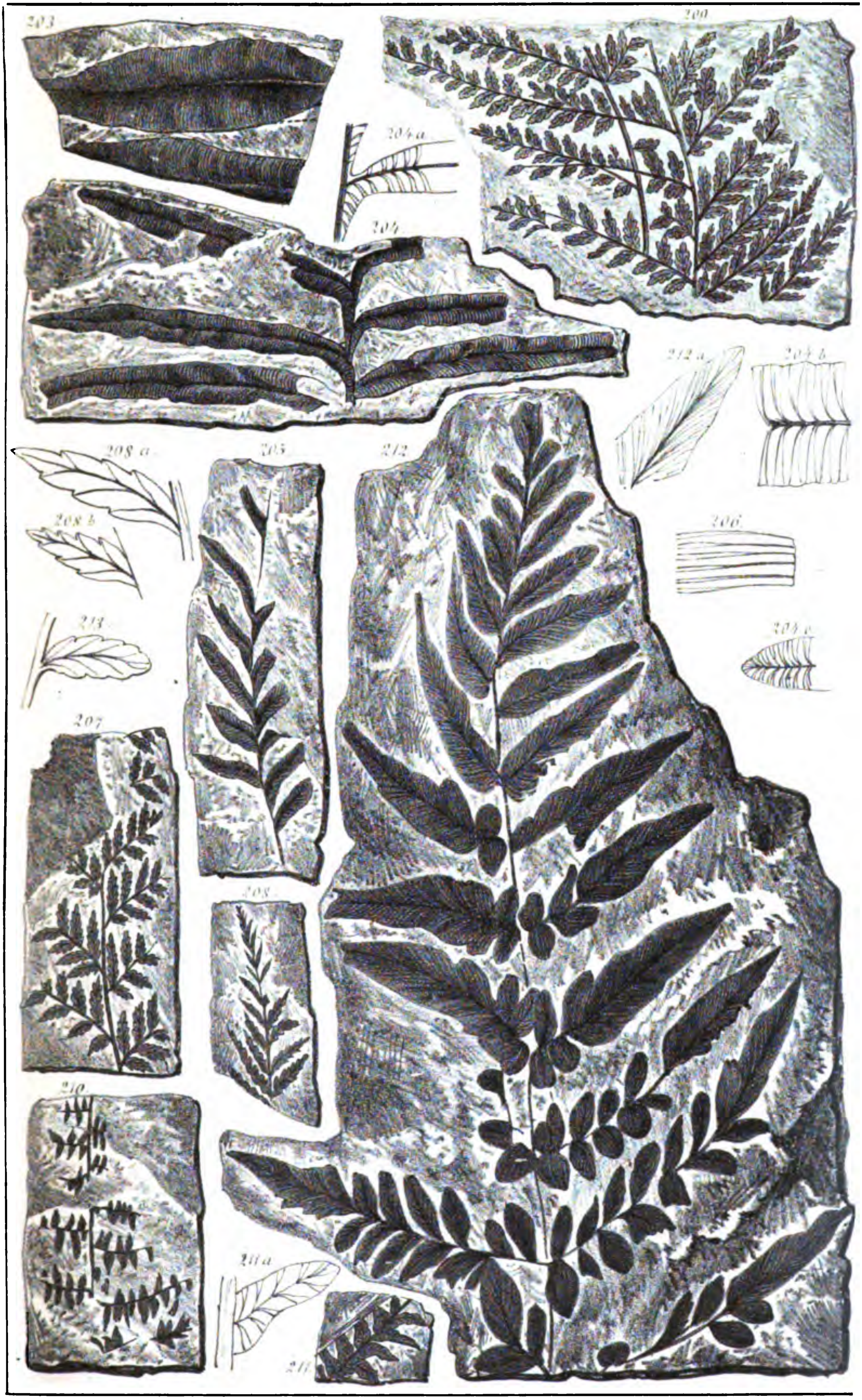


A.L.D. del.
LEGGO & Co Lith. Mo:

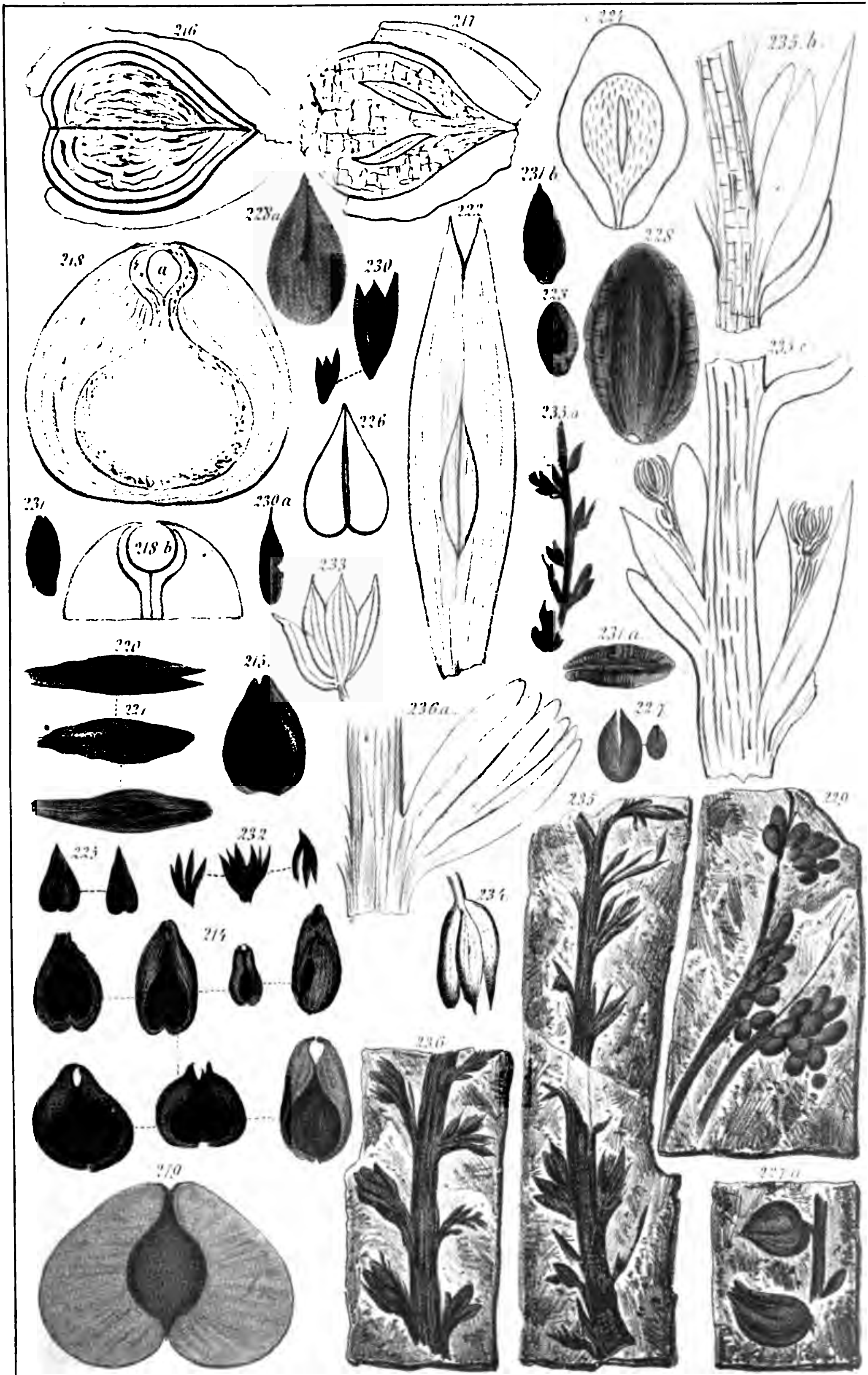
SPHENOPTERIS, &c.



NEUROPTERIS, &c.



ALETHOPTERIS & NEUROPTERIS.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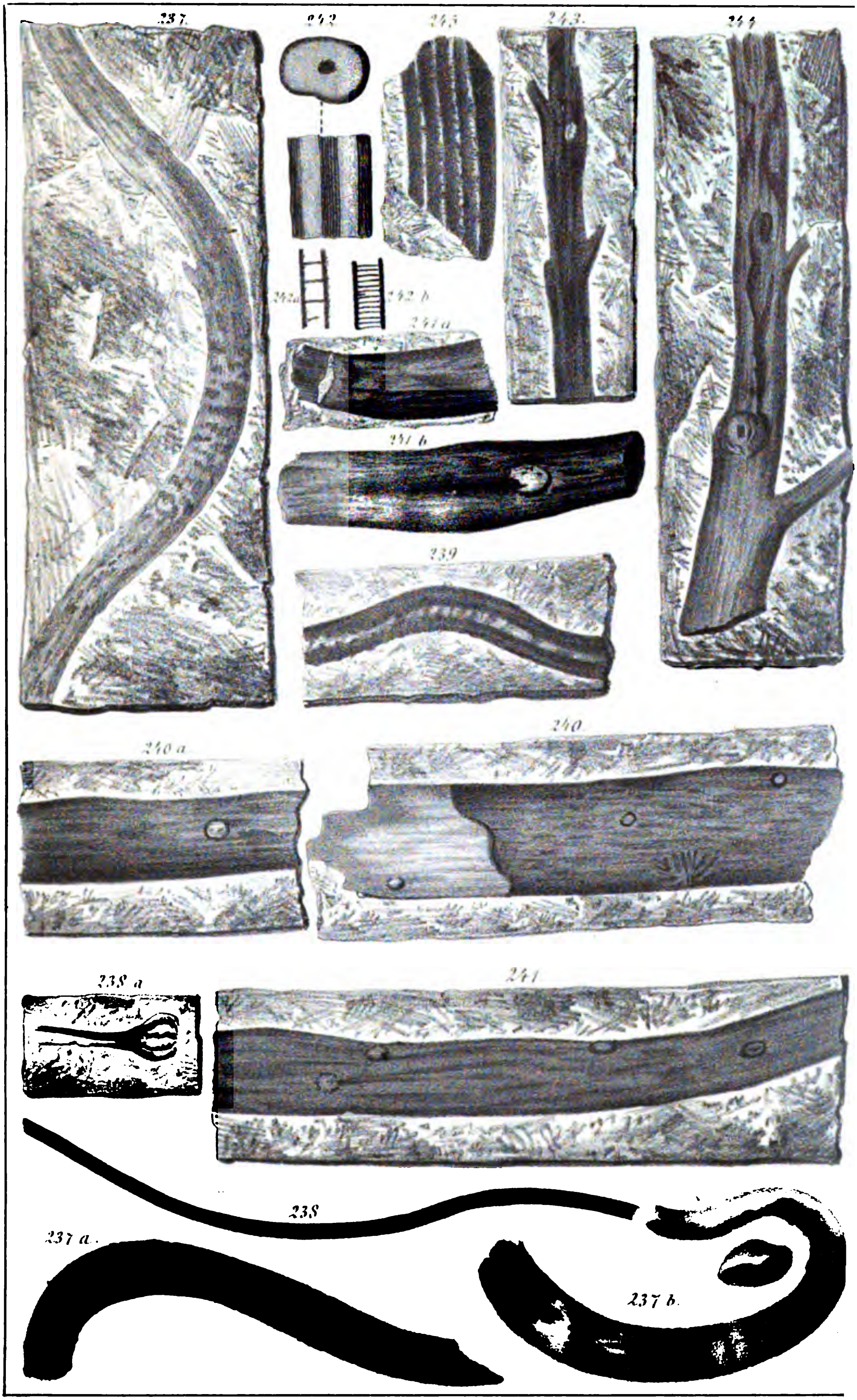

UPPER SILURIAN PLANTS.

Date Due

MAR 1976

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